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WORLD CROPS

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Editorial Comment

The air age of agriculture

THE air age of agriculture can definitely be said to have arrived and it is on this account that we have devoted a considerable section of the present issue of WORLD CROPS to various aspects of the application of aviation to agriculture.

The development of aviation undoubtedly received an enormous impetus from the experience of two world wars. The 1914-18 war first directed man's attention to the inherent possibilities, while we are now in process of applying the many developments in aerial technique which materialised during the struggle of 1939-45 to the peaceful pursuits of agricultural development and the practice of husbandry.

Following ancient precedent, mankind is once more turning, if not swords into ploughshares, at least adapting his war planes to such operations as sowing and manuring his crops, protecting them against pests and diseases, mapping and laying out his farm lands and on occasion transporting his produce to market.

During the period between the two wars considerable developments in this direction occurred and, in the U.S.A. more particularly, aerial spraying and dusting assumed practical importance, while aerial surveying and mapping became recognised as the cheapest and most effective means of recording topography and replacing or supplementing the laborious work of the ground surveyor.

Since 1946 developments have been accelerated, new inventions and discoveries such as radar have been brought into action to help the air surveyor, special types of aeroplane have been designed to meet the requirements of particular operations, sprayers and dusters have been invented or adapted for use in aeroplanes and special ways of compounding and preparing fertilisers, insecticides and weedicides for application from the air have appeared. Moreover, the advent of the helicopter has greatly widened the possibilities with its powers of hovering, thereby proving a useful alternative and supplement to the fixed-wing aircraft, which perforce can only traverse broad swathes of country at relatively high speeds.

While the early developments were mainly confined to the U.S.A., they are now becoming world-wide in their application. In so far as the use of the aeroplane in applying fertilisers or pesticides is concerned, the applicability of the method is greatest where large continuous areas under one crop are concerned, and this has hitherto limited the use of the aeroplane in countries such as Great Britain, where agriculture currently takes the form of relatively small fields of different crops. Elsewhere the case may be different, and a recent noteworthy development is the extensive use of aerial methods of spraying and dusting cotton in the Sudan. Another direction in which developments are taking place is the re-seeding and fertilising of hill grazing lands which is now being extensively applied in New Zealand and has been tried on a fairly large scale on the hill pastures of Wales.

Aerial survey methods have made remarkable strides also and, thanks to recent refinements, it is now no longer necessary to wait upon surface traverses before data can become available regarding new areas which it is sought to develop. Thanks to modern refinements of technique in aerial surveying, the pioneer can now embark upon new enterprises armed with advance information concerning the topography, water supplies and general characters of previously unknown territories.

Air transport is also coming more and more to the fore, especially in the case of perishable produce originating in areas difficult of access, or the transport of heavy essential machinery for crop production or processing. It is also finding its place as part of the personal transport of farmers and their employees where distances are great.

In forestry, too, the aeroplane is gaining wide acceptance as a convenient and efficient method of assessing forest resources, control of pests and diseases and in general administration. It is particularly valuable, for example, in detecting the occurrence of forest fires.

While the possibilities are great and almost unforeseeable, it would be unwise to paint too bright a picture, since like everything else the aeroplane must have its limitations. In many respects we are still in the experimental stage. It is significant that in California a recent law enacts that no pilot may undertake the operations of distributing materials for pest control unless he has an official certificate of competence.

Meantime, there is no doubt that the aeroplane is playing and will continue to play an increasingly important part in agricultural operations.

Land resettlement

THE article by Dr. C. de Fellner in this issue, giving a summarised account of the present position of agriculture in Yugoslavia, is of more than passing interest, firstly because data concerning agricultural progress and developments in communist countries are welcome from a general point of view and, secondly, which is more important,

because all developments in the reorganisation of peasant agriculture are worthy of careful study no matter whether they relate to countries behind the Iron Curtain, to one, as in the case of Yugoslavia, which although communist is outside the sphere of Soviet Russian influence or to non-communist countries.

The move towards cooperative collectivisation of agriculture in Yugoslavia is apparently motivated not so much by unsatisfactory agrarian conditions or excessive pressure on the land as by the urge to release more labour for industrial development. The substitution of mechanisation for hand labour is impelled primarily by the need to maintain agricultural production at existing levels with a reduced agricultural labour force, rather than by the intention to improve production and to obtain higher yields, although no doubt this motive also exists. In this respect the position is not dissimilar to that which occurred in Russia where increased industrial output was a primary point in Soviet economic policy.

It is noteworthy that this is the exact antithesis of what occurred in many Western countries under *laisser faire*, where industrial development in urban areas attracted a large proportion of the rural population to urban areas and economic conditions led perforce to mechanisation.

It is also the reverse of the conditions which are leading to resettlement schemes in other parts of the world. Here, excessive population pressure on the land, uneconomical smallholdings, low yields and declining fertility are inducing some governments to embark upon programmes of population transfer, redistribution of holdings and the opening up of new areas under forms of grouped settlement with the introduction of mechanical methods and improved practices, combined wherever possible with such measures of industrialisation as may be feasible, to help to absorb excesses of population which cannot be used in agriculture.

It is also noteworthy that, although the manner in which the problem arose is very different, in all three cases there are strong resemblances. The factors of resettlement, grouping and industrialisation are present in each aspect, and everywhere the approach is largely experimental. Consequently the lessons and experience gained in each can be of value to the other, when due regard is paid to local conditions. Unfortunately, in most communist-controlled territories the matter is so beclouded by ideological and political controversy that objective study of the position is very difficult while reports of the results are often biased by attempts to present details in propagandist form.

The possibilities of the cooperative farm deserve careful consideration in under-developed regions like parts of Africa where communal or tribal systems of land ownership are breaking down. On this account the factual outline of the present conditions in Yugoslavia contained in Dr. Fellner's article is of considerable interest.

Agricultural engineering

THE Institution of British Agricultural Engineers has now been in existence for 13 years, and in his presidential address delivered in October last Mr. F. E. Rowland commented upon its growth and the important part which engineering plays in agriculture today. There is, we suppose, hardly any industry which presents a greater variety of engineering problems than does agriculture, and it is because these have hitherto presented themselves as a series of separate issues each to be dealt with by the specialist in his own line, that, at any rate in Britain, it is only comparatively recently that it has become recognised that agricultural engineering is entitled to be regarded as a separate entity.

The great extension of mechanisation on the farm has, undoubtedly, given the necessary impetus; it has led to the inauguration of the Institution itself, to the foundation of the National Institute of Agricultural Engineering at Silsoe and the inauguration of a degree in Agricultural Engineering at one British University, Durham.

Mechanisation of tillage, harvesting and haulage gives rise to specialised engineering problems demanding expert knowledge not only of machinery but also of the conditions to which it is applied. The manufacture, not only of tractors, ploughs, cultivators, but also of the ever increasing range of machinery of other types, *e.g.* sprayers and pumps, necessitates more than superficial acquaintance with farming operations ; the successful agricultural engineer must know not only how to build machines but how to use them and this requires knowledge of engineering and also of farming and the scientific principles underlying it.

But the matter does not end there. Engineering on the civil side is equally important ; the construction of farm buildings and farm roads are engineering problems with their own special aspects. Drainage and irrigation are equally important ; too often in the past they have, especially the latter, been considered purely as engineering problems, and little regard has been paid, for example, to the manner in which water is used after it has been impounded in reservoirs. And especially is engineering assuming importance in connection with the control of soil losses by erosion, perhaps not so much in Great Britain but certainly in vast regions in other countries.

The recognition of agricultural engineering as a distinct profession has come somewhat later in Great Britain than in some other countries. Thus in the U.S.A. the American Society of Agricultural Engineers has been in existence since 1907, while

the diploma of Ingenieur Agronome has been granted by a number of French Universities for many years.

The British Institution therefore fills a definite gap ; its functions are described by its President as including the general advancement of agricultural engineering and the provision of professional status for its members. In the latter aspect education and professional standards of competence are of first importance ; even more outstanding an event is the institution within the past year of a National Diploma in Agricultural Engineering corresponding to the older National Diplomas in Agriculture and Dairying. In bringing this about the Institution can claim to have played a prominent part. It is to be expected that in due course other Universities will also follow the example of Durham in instituting degrees in this subject and it would appear that at long last agricultural engineering will attain the recognition as a separate and distinct profession to which it is undoubtedly entitled.

The British General Election

IN Britain the subject which has taken precedence over all others during the past weeks is the General Election, which has resulted in the return to power of a Conservative Government, with Mr. Churchill as Prime Minister, by the small overall majority of 18 seats in the House of Commons. So far as agricultural policy is concerned it seems unlikely that the change will result in any major alterations in the U.K., since in the previous Parliament the major provisions of the Agriculture Act of 1947 were generally approved by both parties. The step already taken to place the working of the Ministries of Agriculture and Food under the general supervision of Lord Woolton as Lord President of the Council seems likely to prove valuable, since it should ensure better co-ordination of the work of these two vital organisations. No doubt, farmers are hoping for some relaxation of the numerous controls and regulations which have been a source of so much complaint, but the extent to which this will prove practicable can only appear after some time.

It also remains to be seen how far the change will affect policy for agriculture overseas. No one will gainsay that the new Government are faced with numerous difficulties and all will wish them well in their task, since on the evolution and maintenance of a sound and progressive agricultural policy the future is bound in large measure to depend.

But, although there may be agreement on basic principles, the new Government will be faced with many knotty problems of detail left in the air by their predecessors. Overshadowing all is the financial situation and the fact that for the first time Britain is in debt not only to the dollar countries, but also to her European neighbours, which emphasises the urgency of further stepping up domestic agricultural production. One of the problems will be the revised price review, for which the previous Government recognised there was a case but deferred a decision until after the election. Another is fertiliser supplies and the possibility of reviving the fertiliser subsidy. Marketing problems also are pressingly important, especially for horticultural produce, and the effects of competitive imports from creditor countries. The appointment of Sir Thomas Dugdale, who is himself a practising farmer with wide experience of Parliamentary practice, as Minister of Agriculture working with Lord Woolton, who as Minister of Food during the war was universally acclaimed, at least gives promise that these difficult matters will be handled with judgment, knowledge and energy.

The end of the year

ANOTHER year is nearly over and we come to the end of our third volume. This issue, incidentally, contains a comprehensive index covering the contents of the last twelve issues. We have published articles on a large variety of crops, ranging from the new cocoa plantations of Malaya to the age-old practice of teasel growing in Somerset. Many countries have been featured and we have tried to include as wide a variety of crops as possible, consistent with the space at our disposal. We have reported on shows and conferences and kept readers informed on scientific developments as they appeared. We cannot expect to cover everything, but we hope we have included most of the important developments.

Looking ahead to 1952, the future is still, politically and economically, uncertain ; the primary industry of agriculture is increasing its production slowly, although not fast enough to supply the needs of a growing world population. However, the acceleration has started and we can look forward optimistically to a greater increase in world crop production next year.

Meanwhile, Christmas is approaching and to all our readers, whether they be in the tropics or the far north of Canada, we wish the age-old sentiment, 'A Happy Christmas.'

THIS MONTH'S COVER

A Tiger Moth, equipped for crop dusting, flying over a field at low elevation.

(Photo: De Havilland Aircraft Co.)

The Application of Aircraft to Agriculture

P. H. SOUTHWELL

National Institute of Agricultural Engineering

Today the aeroplane is finding ever-increasing application and its use in agriculture is one of the outstanding features. In this article the history of the development of aircraft for agricultural operations is reviewed and their limitations and advantages are discussed.

IT is not proposed in this short article to deal with the aeronautical aspects of the subject, or to mention more than briefly the equipment which has been designed for installation in aircraft so employed. The aeronautical aspects are discussed in another paper by the author, which is to be published by the Royal Aeronautical Society. The primary concern here is the agricultural aspects of the subject.

After the first world war investigations were begun with the idea of utilising the aeroplanes of the day for agricultural work. In the U.S.A. experiments in the dispersal of insecticidal dusts by this comparatively new means were successfully made as early as 1921 in Ohio. A United States Department of Agriculture bulletin of 1924 recorded the results of experiments on the dusting of cotton by ex-military training biplanes, capable of carrying some 350 lb. in the second cockpit. At the beginning of these trials the dust feed was operated by an observer who stood up in the cockpit space remaining behind the hopper ; this method was, however, soon improved upon.

In South Africa blue gum plantations on the Rand were dusted with calcium arsenate in 1926 and three-engined aeroplanes were used about 1934 for dusting locust swarms in Zululand and treating pine plantations in East Transvaal. A great deal of useful experience was obtained during this work, but there was clearly a need for aircraft which were more safe and manoeuvrable at the necessarily low heights. The position was improved upon in South Africa a few years later by the introduction of an aeroplane carrying a 900-lb. load and capable of satisfactory operation at heights as low as 30 ft. ; this machine was quite extensively used as a means of dusting wattle plantations.

On the other hand, initial experiments in the United Kingdom had discouraging results, mainly because of the small fields (with consequent problem of drifting) and the number of trees and hedges. The major lessons which were learnt as a result of the early work on crop dusting by means of aircraft were therefore three in number. Firstly, the possibilities of aircraft application were much greater over large areas then in small countries having highly developed agricultural industries. Secondly, improvements were required in the operational suitability of the aircraft available. Thirdly, aeroplanes could be used successfully and in many cases possessed distinct advantages over ground machines ; for instance, in rate of work, timeliness of crop treatment, independence of land condition and reduction of cost per acre. The control of gypsy moth in the U.S.A. cost 15 to 25 dollars per acre with ground machinery, but the introduction of small aircraft for the work reduced this charge to some 1½ dollars/acre and it has been further reduced by the use of modern twin-engined aeroplanes.

With spray tank mounted in the front cockpit and equipped with a wind-driven propellor driving a centrifugal pump a biplane carries out spraying tests at Beltsville, Maryland

Further progress

The pioneering work of the 1920s was in large part brought about by enthusiasm and was assisted by a certain air-mindedness following the 1914-18 war. It merits applause as an example of the search for applications in which aircraft may be of true service to civilisation, and it is somewhat regrettable that greater progress was not made in the agricultural sphere between the two great wars. In North America, however, crop dusting from aircraft was quickly placed on a commercial basis and steadily grew by a system of custom (contract) operation into an important service.

The recent World War 2 has again stimulated public air-mindedness, but the position at the present day is more favourable to agricultural aviation than it was in the 1920s. On the one hand, the types of aircraft available are rather more suitable, and the helicopter is approaching fruition. On the other hand, concentrated insecticidal liquids which permit low dosage have been evolved and greater action is being taken to develop world agriculture. These factors combined have considerably increased the potentialities of aircraft application in agriculture. There is a further point : the utilisation of aircraft by individual farmers is very much interrelated to the general use of small, safe, ' family-size ' machines for personal trans-

port—as the automobile is used today. This development has not as yet materialised ; when it does the first steps will in all probability be taken amongst rural communities.

Dusting

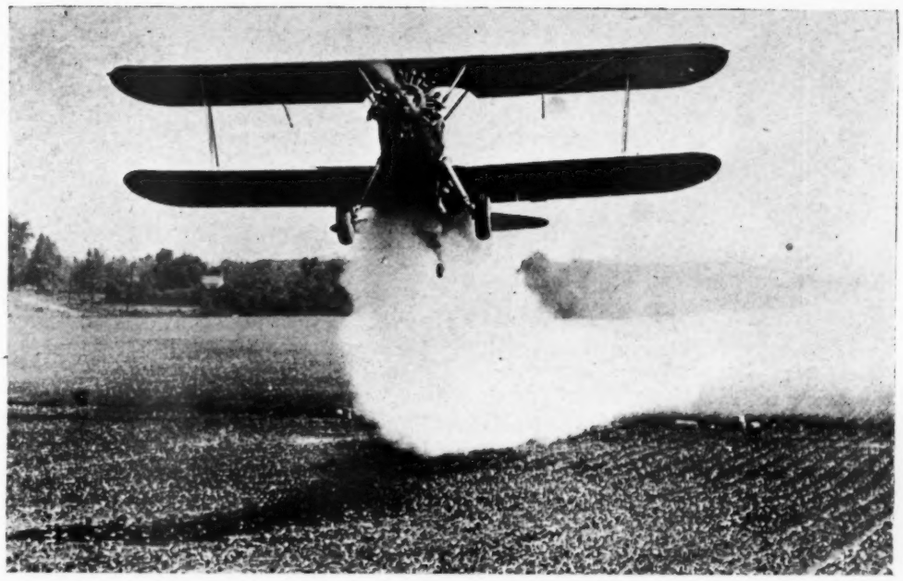
A typical aircraft installation for dust dispersal has a hopper with two agitators, one in and one above the throat, and the air flow past the hopper outlet below the fuselage is accelerated by means of a venturi. Air is thus loaded with dust and falls massively, assisted by the aircraft slipstream but perhaps otherwise by the wind. The danger is that once fine particles have been carried up they take a very long time to settle and there is then a likelihood of drifting. This is not uncommon with ground machines, but in the case of hormone or selective weed-killers the risk of damage to other crops is grave. The evolution of concentrated liquid sprays may lead to the supercession of dusting in many areas, but a new dust ' filler ' which is reputed to carry insecticides satisfactorily and at the same time promote deposition on the ground by being less amenable to ' suspension ' in air, has recently been developed in the U.K.

In 1936 the average price for dusting cotton in the U.S.A. by means of aircraft (exclusive of the cost of dust) was 4.5 cents/lb., and a small aeroplane carrying about 500 lb. engaged in this type of work has been considered capable of treating 350 acres per hour, a typical average time analysis per load being as follows : loading time, 3 min. ; total flying time, 14 min. ; time of dust dispersal, 5 min. In addition to treatment of cotton against the boll weevil, dusting at 20 to 30 lb. per acre can also be carried out to defoliate fully-grown plants under heavy dew or high-humidity conditions in order to hasten boll maturity and assist the mechanical pickers. Without damage to the crop, this work is only possible by means of aircraft.

Of recent years, dusting has also been carried out from helicopters. This is reputed to be more efficient than ' drift ' dusting (and some ground methods) because the material is forced down, but the dust must be correctly introduced to the rotor downwash or damage to the aircraft may occur.

Spraying

The requirements in agricultural spraying are well known and the major advantages of aircraft over ground machines for spraying equipment are timeliness of application, speed of work, independence of ground condition and absence of mechanical damage to the crop. The only question in the minds of agriculturists is whether aircraft can carry out normal spraying work as efficiently as ground machines at a comparable cost.



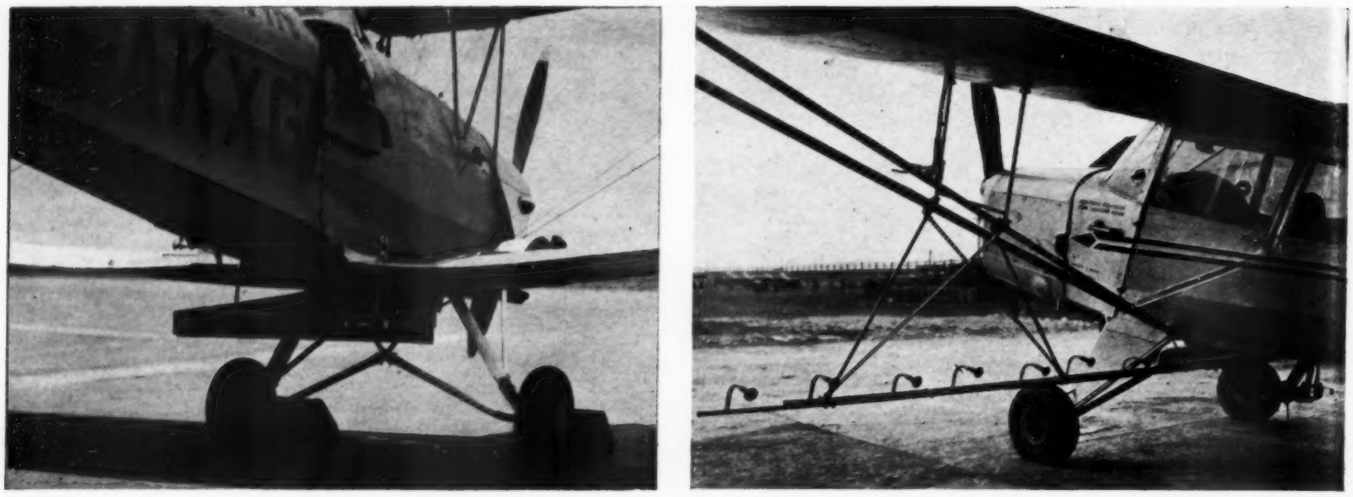
Crop dusting from the air in the U.S.A. This aircraft is dusting broccoli with an insecticidal mixture

There are two known methods of spraying from the air. The first is by an aircraft flying at 100 to 500 ft. and freely emitting a liquid insecticide ; the second is by an aircraft fitted with a pressure-fed spray boom and flying at just above crop height. The first method is more generally used for large-scale operations and has been applied in locust control and over forest areas. It will be appreciated that as the liquid is poured out of the aircraft fuselage it is shattered into drops of various sizes by the air stream. These drops become controlled by the wind and a common practice is for the aircraft to fly at right-angles to wind direction so that the ' spray ' is blown downwind from the line of flight. This will give rise to a ' sheet ' drifting on the wind and ultimately to a wide band of deposit on the ground with the larger drops on the upwind edge and the smaller drops on the downwind edge. Hence the problem in the production of a reasonably constant deposit density is in the correlation of emission rate, aircraft height, swathe width and distance between aircraft runs over the area. This has been found quite possible, especially in stable air conditions, *i.e.* with a steady wind speed of less than 10 m.p.h., and with no thermal air currents. The ideal solvent has a sufficiently low vapour pressure to enable the drops to be deposited on the ground before appreciable volatisation occurs.

The second method is in effect the mounting of a spray boom, tank and pump on an airborne prime mover instead of on a ground-supported chassis. By this means damage to crops is avoided irrespective of their growing condition ; tall crops do not require more specialised equipment ; wet land conditions are no hindrance (thus irrigated areas need not be drained) and the work is speeded up. The latter point is of particular importance in combating epidemics which have already begun or are expected. For large-scale operations at the greater aircraft heights the spray-boom method is used in the U.S.A., whereas elsewhere the free-emission system is more generally applied. A well-known American twin-engined aircraft carrying 900 gal. of insecticide has been equipped with spray-boom apparatus capable of delivering up to 200 gal./min., and at 150 ft. and 150 m.p.h. of achieving a distribution rate of 1 gal./acre.

In operations over small areas the spray-boom system is commonly used and, in order to assist spray deposition on the under-surfaces of foliage, helicopters have been so equipped. Although the capital and running costs of a helicopter are at the present time considerably higher than those of a fixed-wing aeroplane having the same payload, the advantage is that spray can be introduced into the rotor downwash and the crop interference to the air/chemical stream gives a high dynamic catch on all foliage surfaces. Rate of work is usually lower than in the case of fixed-wing aeroplanes but satisfactory operations can be carried out under higher wind speeds, providing there is no gusting, and a more efficient job is often done—more efficient than some ground machines.

An appreciable amount of research has been carried out in the U.S.A. and the



Two methods of application: (*left*) dusting and (*right*) spraying. In both cases the air stream from the propellor plays an important part in dispersing the dust or spray

U.K. concerning the two methods of spraying which have been outlined above. For instance, investigations have been made into the form of a helicopter rotor downwash and the section of it into which the spray can be most advantageously fed and also into the angles at which spray nozzles on fixed-wing aircraft should be set.

It will be appreciated that the high rate of working which is possible will permit a small number of aircraft operating on a contract basis to carry out the spraying requirements of a very large area. The continent of Africa, for example, with its range of crops and deviation in time of seasons would appear suitable for such a system. A major advantage of aircraft is mobility and, given an adequate supply organisation, it is possible to have an aircraft fleet continuously employed throughout the year by carrying out spraying operations over adjacent parts of the world in due season.

In addition to agricultural pest and weed control measures, aeroplanes have been utilised for hormone spraying to prevent the pre-drop of fruit ; by means of aircraft there is little interference with the harvest effort. In another connection, helicopters have been found particularly suitable for anti-mosquito spraying because they can reach pools obscured by overhanging rocks and so forth.

The dissemination of smokes may also be included here. Aircraft are not suitable for crop treatment by fumigation because vapour concentration cannot be held for a sufficient time to ensure mortality, but the production of 'smokes' to combat freely flying insects has met with success. Smokes are normally produced by vaporisation through injection in the aero-engine exhaust system, on leaving which condensation gives rise to a cloud. Helicopters have also been fitted with this equipment in order that land pockets such as ravines and gullies can be treated. A large area can be covered in a very short time and the method has, for instance, been found suitable against the tsetse fly and wattle bagworm.

Distribution of seeds and fertilisers

Aircraft provide the only practical means of fertiliser and seed distribution over hill lands and can play a great part in the improvement of poor grazing of this type and of marginal areas.

The method of dispersal is similar to that employed in the free emission of liquids from aircraft but the influence of wind is reduced except in the case of mixtures, where a winnowing effect—as with liquid drops of various sizes—will obtain. This is of greatest importance with seed mixtures (e.g. subterranean and white clover), the lighter seeds being carried further by the wind, and has led to the introduction of pelleting in order to obtain uniformity and an increase of weight and volume as required. The coating also protects the seed and dissolves after ground penetration, thereby promoting a high germination rate. Similarly, granular fertilisers of uniform size in pellet form have been introduced. Commercial superphosphate, for example, consists of a mixture of granular and dusty material and has been found unsatisfactory for deposition from heights above 150 ft. or so.

Advantages of aerial distribution

Trials have shown that, although there are problems in this sphere which need to be solved, efficient distribution can be obtained by accurate ground control. The application of aircraft for the distribution of fertilisers in area improvement schemes has distinct advantages : fertiliser has been delivered direct from the factory to the land requiring it by this means and progress is being made, for example, in New Zealand, Australia and the U.K. The results of research concerning germination rates when oversowing will have a direct bearing on the applications of aircraft in grazing land development work. Providing the surface is not dry, hard and impenetrable, seed is usually sown when rain is expected or, failing that, immediately after rainfall. Seed dispersal from aircraft is particularly valuable when the land is newly cleared and has been burnt over, or bears numerous rocks and stumps, or is wet. When land is very wet, or has been recently flooded, the soil will be in a condition to germinate seed before it is capable of supporting machinery (which must be propelled over it by wheel or track with consequent possible damage to soil structure). In cases of extensive flooding, the sowing of a surface crop, if only as a cover crop, may assist in the rapid rehabilitation of the land. A more important application is in the sowing of rice. The dispersal of pregerminated seed is possible and about 90% of the Californian rice crop is now sown from aircraft, a large portion being fertilised and treated with selective weed killer by the same means.

Some estimate of the potentialities of top-dressing hill and marginal lands from the air may perhaps be derived from the fact that small aircraft on short hauls (*i.e.* being used primarily for elevation and distribution of the material) and capable of carrying 4 to 5 cwt. have achieved dis-

tribution rates of 20 tons per flying day. At 2 cwt./acre and assuming 120 flying days per annum, it is therefore possible to treat some 24,000 acres per year with each aircraft. Contract operators in New Zealand using small aircraft have recently been charging from 6s. to 10s. per acre for this type of work.

In addition, multi-engined aircraft can be employed when high distribution rates per acre are required, for example in the dispersal of lime, perhaps being used for long-distance haulage as well as distribution of the material. Other applications of aircraft are in the remedying of trace element deficiencies, the dispersal of baits and the sowing of seed to promote soil aggregation in order to rehabilitate erosion trouble spots. A further example in the latter sphere is the distribution of lupin seed to ' fix ' sand dunes.

View of three two-ton hoppers installed in a freighter aircraft for top-dressing grassland with fertiliser from the air. The hopper controls are manually operated

Transport

Freight transport by aircraft permits a wider market for perishable products and, for instance, fruit and vegetables can be harvested in a riper and marketed in a fresher condition. It has also found application in the movement of livestock and the transport of carcases from inland ranches to factory or port, thus eliminating the much-publicised treks on the hoof. The great value of aircraft as a means of transport which is independent of ground conditions has been illustrated by the location of herds and the dropping of fodder to keep them alive during the very severe snowfalls and floods of recent years —notably in the ranching areas of Australia and the U.S.A.

The extent to which the aeroplane is becoming established as an item of farm equipment is perhaps indicated by the National Flying Farmers Association in America, the membership of which was given as 6,500 in 1949. A small aircraft will enable a rancher to, for instance, ' ride fences ' more rapidly and, although a small airstrip may have to be laid down or a lake utilised, snow is no barrier nor to the same extent is mud. It will also permit a wider sphere of activities and reduce the incidence of narrow-minded remoteness. It is for reasons such as these and other domestic considerations that ' pasture pilots ' and the market for family-size planes exists. Furthermore, the development of road communications for agriculture is a costly business imposing a high charge on the community as well as the cost of vehicle purchase by the individual farmer.

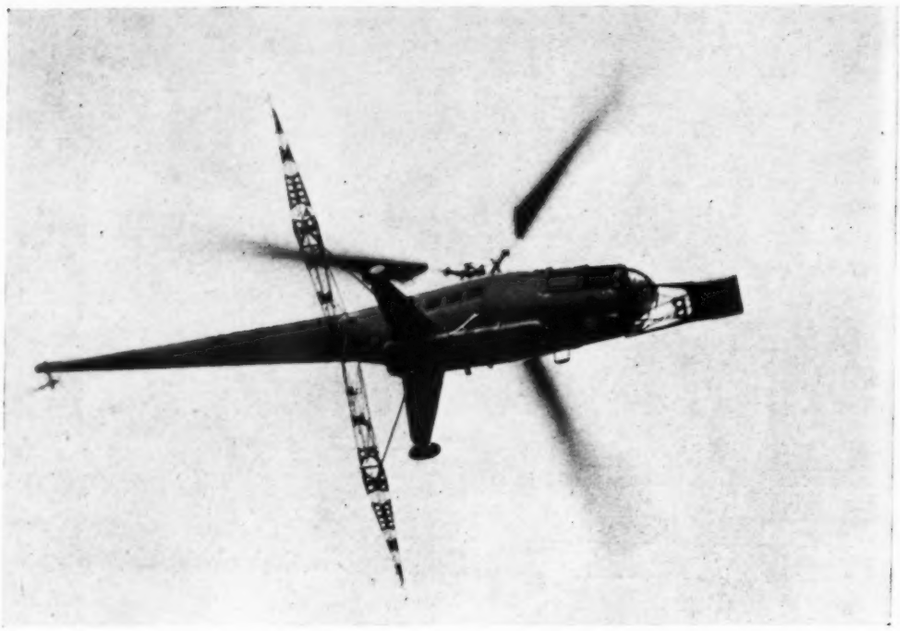
Five tons of lime being dropped over the Welsh hills by a freighter aircraft. One ' drop ' covers 20 acres at 5 cwt. an acre

The use of aircraft as a means of personal transport also assists the work of agricultural management and advisory personnel. The wide range of vision afforded with close inspection where necessary is of particular value in connection with soil conservation and pest control in a territory. Similarly, aircraft can be useful in the overall supervision of timber-cutting operations and the detection and control of forest fires, which most often occur in very inaccessible places. Methods of aerial survey have been well developed and, for instance, aerial photographs are becoming widely used as base maps for field surveys by conservation service personnel.

It may be pointed out that small, suitably designed aeroplanes which are individually operated by farmers may not only carry out the functions of automobiles without the expense of road network construction but may also undertake certain agricultural operations independent of ground con-

ditions. Ease of interchangeability of equipment and suitability for carriage of both persons and freight are therefore important factors in the design of ' flying jeeps ' and the spread of capital expenditure by a variety of uses with such machines leads to a lower apparent cost.

It is becoming increasingly apparent that aircraft can be of considerable service in world agriculture. They provide a means of propulsion for certain equipment and a means of transportation for goods and persons which is independent of surface conditions, that is, independent of the state of the soil, of the terrain and of the crops. Furthermore, by virtue of their mobility they are capable of use on a contract basis over a continent or large area according to requirements. At the time of writing the application of aircraft to work which cannot so easily be carried out by ground machines is virtually established and only requires extension ; aircraft, particularly helicopters, are now beginning to *compete* with ground machines in specialised tasks and even over low crops and dry, flat soils.



The future of the helicopter is very bright in the agricultural field

Photos : p. 465, U.S.I.S., p. 466 left, de Havilland Aircraft Co., right, Shell, p. 467, Bristol Aeroplane Co., p. 468, N.A.I.E

Aerial Crop Spraying in the Sudan

As an example of large-scale crop spraying successfully accomplished under tropical conditions with fixed wing aircraft, the following account of operations undertaken in 1950 for the control of jassids on cotton in the Anglo-Egyptian Sudan is of interest.

The story commenced in September 1950, when three Auster ' Aiglets ' belonging to Aerial Spraying Contractors Ltd., of Boston, Lincolnshire, and fully equipped with spraying equipment, flew from Boston to Khartoum. This, a distance of some 3,200 miles, was completed without mishap in 34 flying hours spread over 10 days.

The purpose of this flight was to undertake the spraying of 17,000 acres of cotton against cotton jassid (*Empoasca Libyca*), an insect which lives and feeds on the underside of the leaves.

Operations, 100 miles south of Khartoum, commenced on October 1, 1950, and lasted until November 7, 1950, during which time a total of 300 hours was flown. This time included test flying, equipment checking and some few hours of communications work, giving an overall average of some 57 acres per flying hour and an average of almost 70 acres per spraying hour.

The 17,000 acres were situated on both sides of the White Nile over a distance of 120 miles in plots varying in area from 30 acres to 3,000 acres. These areas in turn consisted of fields varying in size from 5 acres to 200 acres.

Obstacles encountered were mainly trees and telephone wires, and although these proved a nuisance, they were not insurmountable. A more serious hazard proved to be the birds encountered. These consisted of flocks of birds ranging in weight from 2-3 oz. to 14 oz., and single birds up to 10 lb. and possibly larger. The only damage inflicted by unintentional flying through the flocks of birds was superficial, being mainly small dents in the leading edge of the wings. Of three large birds hit, one caused a deep indentation in the engine cowling, another damaged a wing tip, and a third struck the windscreen in front of the pilot, possibly after being cut up by the propeller. This third bird caused no damage whatever.

A central air strip was used throughout the operation as a home base. There the aircraft were hangared each night and accommodation and repair facilities were centralised. The aircraft flew out each morning to the improvised landing strips situated as close to the area to be sprayed as possible ; this varied from a few hundred yards to eight miles (a general average being two miles). In no case were the landing strips limited in size, and it was possible to touch down with safety immediately after take-off if the engine failed, but the surfaces varied considerably from very smooth to very rough. There was, however, no undercarriage damage during approximately 1,500 take-offs and landings during the entire operation.

In the 38 days of operation, four complete days were taken on maintenance and a further six days were non-operational due to adverse weather conditions, a local ' Bank Holiday ' and unavoidable delays of ground transport.

The petrol, oil and insecticides were provided by Shell on the outward journey, throughout the operation and on the return journey. The return journey was completed in five days without mishap.

The spraying equipment fitted in the aircraft was designed by Mr. P. C. Andrews, a director of Aerial Spraying Contractors, and consists of a retractable windmill driving a pump inside the aircraft which is connected to the spray tank (of 48 gal. capacity), and a double spray bar beneath the aircraft wings, and incorporates one or two unique features employed in the field of aircraft spraying, which have fully proved their worth in practice (see WORLD CROPS, **3**, 5, 200, May 1951).

All servicing of aircraft and equipment was carried out on the spot and it was not found necessary to utilise any of the comprehensive stock of spares that was carried, either for the aircraft or for the equipment.

The ground filling unit was designed to pre-mix the insecticides, and the spraying system within the aircraft provided for circulation thereafter. The main feature of the ground filling unit was the pump, with which it was possible to fill the aircraft spraying tank in about 25 seconds.

Aerial photograph of a cultivated area in the Middle East. Different crops can be interpreted by the varying tones and textures on the picture

Aerial Photography and Agricultural Development

Aerial photography has now developed into a highly technical science whose uses are many and varied. Development, agriculture and forestry all benefit from this—a fact which is gradually becoming more widely appreciated—and in this article an outline of the type of work which can be carried out from the air in this respect is given.

UNDER the growing pressure of population the increase of agricultural production is everywhere recognised as a number one priority and, in this regard, much attention is being paid to the opening up of undeveloped areas for agriculture. One of the main difficulties here is the fact that often little or nothing is known about the actual conditions. Factual information is often deficient or absent concerning topography, there are no reliable surveys and data about such matters as climate, water supplies, geological and soil conditions, vegetational and ecological conditions and associations are frequently entirely lacking.

In the absence of such information it is impossible to make reliable development plans. The compilation of this basic information by ground methods is a formidable task which often would take considerable time and, consequently, in the past, developments have often been embarked on without it, and only at a later stage have reliable maps been produced. Too often this has caused much waste of money, time and labour, and examples exist of costly failures due to the absence of adequate data on these essential matters.

During the past 30 years or so increasing attention has been paid to the use of aerial surveys as a means of rapidly supplying some of this information at a cost far less than that involved in collecting it by the older method of ground traverses ; today aerial surveys are recognised as an invaluable instrument and with recent developments their use and the purposes which they can be adapted to serve are rapidly extending. They have, of course, their limitations and their use is necessarily conditioned by their correlation with ground observations. Nevertheless, there is no doubt that they can immeasurably hasten and cheapen the provision of essential basic data and extend and supplement usefully the results of ground observations.

Development

Aerial photography on a practical scale was first used during the world war of 1914-18, when it was employed to detect enemy camouflage, locate enemy dispositions and prepare simple operational maps and mosaics. Subsequently it was developed and adapted, at first slowly, to peace-time requirements.

Its widest application has been in the preparation of planimetric and topographic maps. Recent advances in mapping techniques have resulted from the use of stereoscopic plotting instruments, the improvement of aerial photographic equipment and experience gained in the interpretation of air photographs. Today three-dimensional methods of plotting maps from vertical photographs are in general use, not merely for small-scale topographical maps but are equally effective in the production of surveys at scales up to 1 in 500 with contours at intervals as close as 2 ft.

Moreover, air photographs have been applied in economic surveys to provide information on natural resources and land classification and utilisation. In the U.S.A., for example, over 3,000,000 square miles have been photographed by the United States Department of Agriculture for a variety of purposes, including forest classification and inventory, land use classification, soil conservation and the checking of farm programme adjustments. In many other countries their use for similar purposes has expanded enormously.

Agriculture and forestry

Crop surveys can be carried out very rapidly by air photographs and, by studying these stereoscopically, the main types of crop and vegetational cover can be distinguished and their areas computed. By detailed study of the varying tones and textures on the photographs, information

can be obtained on the density of crops and the occurrence of diseased and stunted areas. Air photographs can also be used in planning drainage and irrigation schemes and for studying the incidence of erosion.

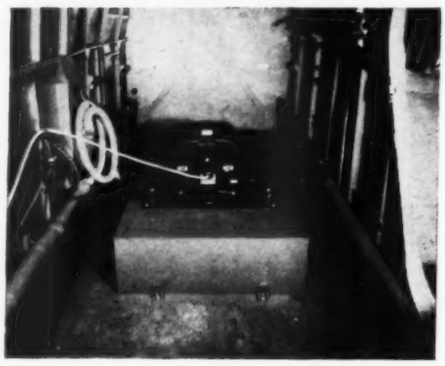
In forestry, air photographs are widely used, from the exploratory stage to the detailed volumetric estimation of timber stands and the planning of extraction programmes. The use of air photographs reduces the amount of essential ground work considerably and provides much information which cannot be obtained by other means. In certain cases, by using different light filters or infra-red film, the identification of different species is facilitated and, by studying photographs stereoscopically, heights of trees can be computed and the stand classified. By rephotographing at intervals the forest inventory map can be kept up to date and fellings rapidly estimated.

The technique of aerial photography

It is impossible here to consider in detail the various technical aspects of aerial photography, but it may be said that specially modified aircraft are needed for the purpose. Air cameras require a high degree of precision and lenses must be as free of distortion as possible. Special types of camera have been developed which have greatly increased the adaptability of air photography and extended its range of usefulness. It is now possible to take large-scale photographs from aircraft flying at high altitudes, while lenses of very high resolution combined with negligible distortion have been developed which enable minute details such as manhole covers, fence posts and railway track detail, etc., to be faithfully recorded and used in the plotting of plans for engineering and development projects.

In normal practice there are two types of air photographs, ' verticals ' and ' obliques.' Vertical photographs are taken with the axis of the camera held as nearly as possible in the vertical direction ; a normal condition is that the degree of tilt should not exceed 2°. They are used for preparing accurate planimetric and contoured topographical maps and for land use surveys and similar purposes. They have the advantages that they provide a ' bird's-eye ' view of the country, can be viewed stereoscopically and are best suited to the requirements of mapping and specialist interpretation.

Oblique photographs are taken with the camera axis intentionally inclined to the vertical ; they may include the horizon when they are termed ' high obliques,' otherwise they are termed ' low obliques.' They are seldom used for mapping as they are much more difficult to deal with than verticals and inevitably contain a lot of ' dead ' ground which cannot be seen. Moreover, the scale and ability to interpret detail varies very rapidly from the foreground to the horizon.



(*Above*) **Airspeed Oxford modified for air survey work**

(*Below*) **Williamson Eagle IX air camera installed in the Oxford**

A method of combining vertical and oblique photography is known as trimetrogon photography. In this, three cameras are mounted together, one of which is vertical and the other two inclined to the horizontal at about 30°, and three photographs are taken simultaneously. It has the advantages that it reduces flying time by about two-thirds, while one strip of verticals is produced for every flight which can be used stereoscopically. Trimetrogon photography is only of value for reconnaissance mapping at very small scales and in providing a general classification such as may be required in certain types of land use and forest surveys.

Mapping and mosaics

Mosaics are assemblies of individual air photographs forming a single picture. They give a fairly accurate overall picture of a larger area than is possible from a single photograph and show salient features of topography, structures, roads, rivers and so on in more detail than can be shown on a planimetric or topographical map.

Mosaics may be either ' uncontrolled ' or ' controlled.' Uncontrolled mosaics are made by simply trimming the separate prints and matching them by common features within the areas of overlap, without scale adjustment or reference to ground control. The assembled photographs are usually rephotographed in a copying camera for reproduction. Controlled mosaics are co-ordinated to ground control, supplemented by radial triangulation, while the scale of each photograph is adjusted by copying it in a projecting camera. The copied photographs are assembled by fitting them to the network of ground control points plotted on the mosaic board.

Mosaics are useful as a means of recording field data and to take the place of a map in unsurveyed territories. They also provide the geologist and specialist interpreters with a regional view of the country which cannot be obtained by any other means.

Interpretation of air photographs

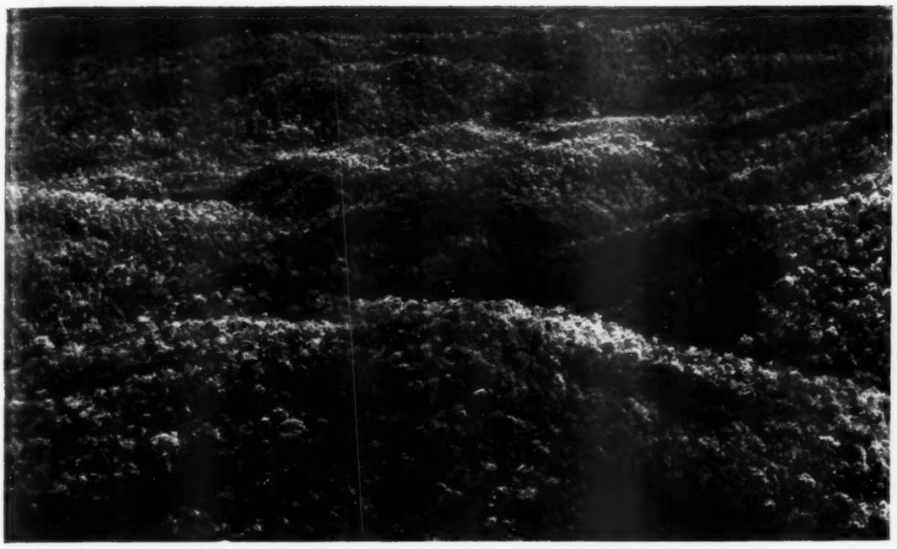
The interpretation of aerial photographs depends on knowing the significance of the pictorial elements—tone, shadow texture and outline—and the manner which these are effected by optical influences. This knowledge, combined with familiarity with field conditions in the area being surveyed, enables operators to distinguish vegetational types and physical features.

A particularly valuable point is that they can be examined stereoscopically, since this gives a three-dimensional picture of the region under study and enables topographical details to be observed. This is of primary importance in land use surveys, particularly in regard to cultivability, drainage or liability to erosive influences. Moreover, under favourable conditions, soil types can be distinguished directly; more commonly they can be identified on the basis of their known vegetational and ecological associations.

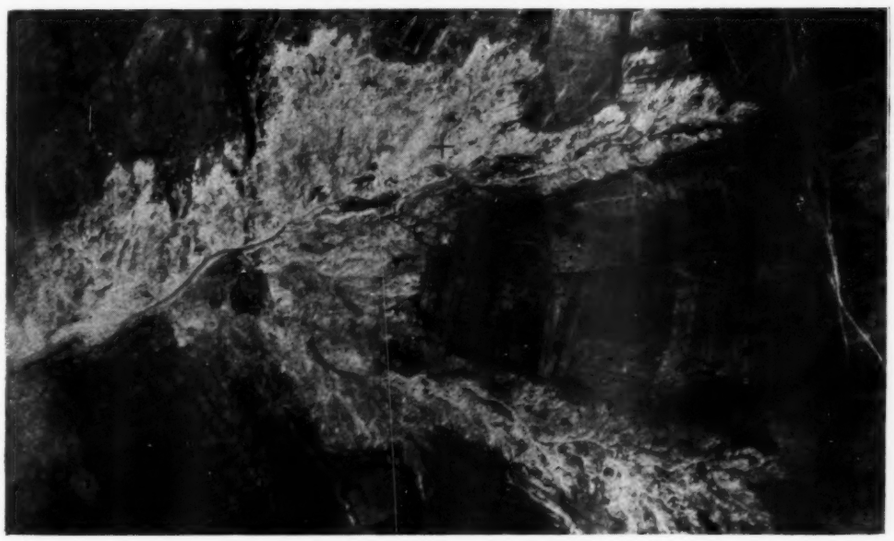
In work of this type the value of panchromatic and infra-red films has been demonstrated. Colour photography has also been tried out with limited success, but is nearly always confined to low altitudes owing to the neutralising effect of haze.

Recent technical developments

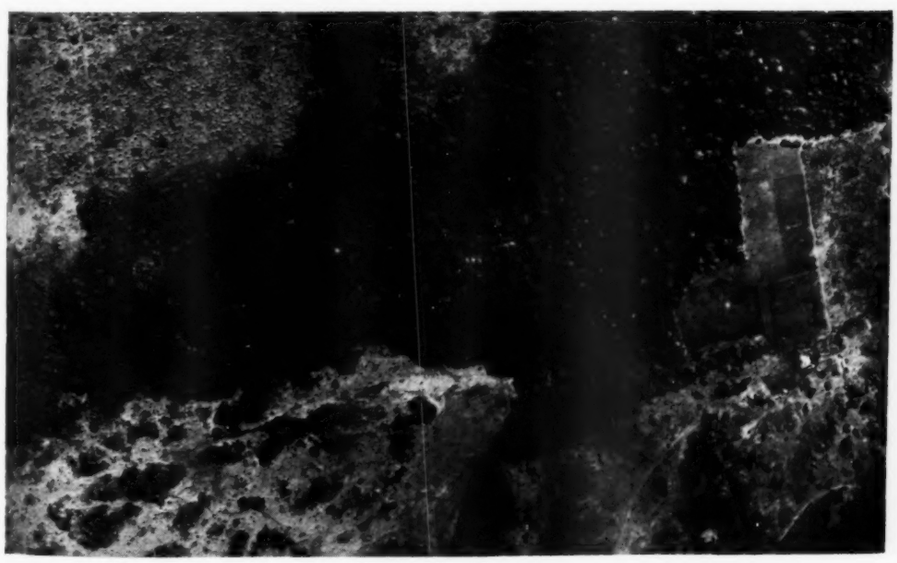
Before it is possible to produce a detailed map from aerophotographic materials they must, as we have seen, be accurately tied to basic data derived from ground observations. Geodetic triangulation is slow and costly and has, in the past, been one of the chief delaying factors in mapping. Two recent major developments which have taken place should materially hasten and



Oblique photograph of a thickly forested area in Siam



Advanced gulley erosion in Kenya



Inroads in forest made by shifting cultivation in Tanganyika

facilitate operations in this regard. The first is the adaptation of the helicopter to aerial surveying, which has hitherto relied entirely on fixed-wing aircraft. The use of helicopters to ground survey parties has very materially improved the position ; for example, it has recently been found in Canada that the employment of a helicopter has made possible the increase of output by eight and one-half times at one-third of the cost.

The second is the adaptation of radar to aerial surveying operations, on the one hand for the measurement of long lines on the ground which previously had to be carried out by ground trignometrical measurements and, on the other, for height control. An instrument known as the airborne profile recorder has recently come into use which enables height control for topographical mapping to be done entirely from the air. It consists of a very narrow radar beam pulse directed downward from the aircraft, the time of return being recorded continuously, thus giving an actual profile of the ground. The idea is, of course, not new, but it is only latterly that it has become an operating tool in surveying.

Practical applications

It is not too much to say that aerial photography is rapidly becoming the accepted form of mapping. As a result of advances in aerial survey technique and the production of precision instruments for the analysis and interpretation of data, information can be obtained rapidly and economically which previously could only be provided at great expenditure of money and effort. Vast areas in many countries are being accurately charted in a fraction of the time which it would have taken by the older methods. It is now possible to survey undeveloped areas, using the word in its widest sense, before any development takes place.

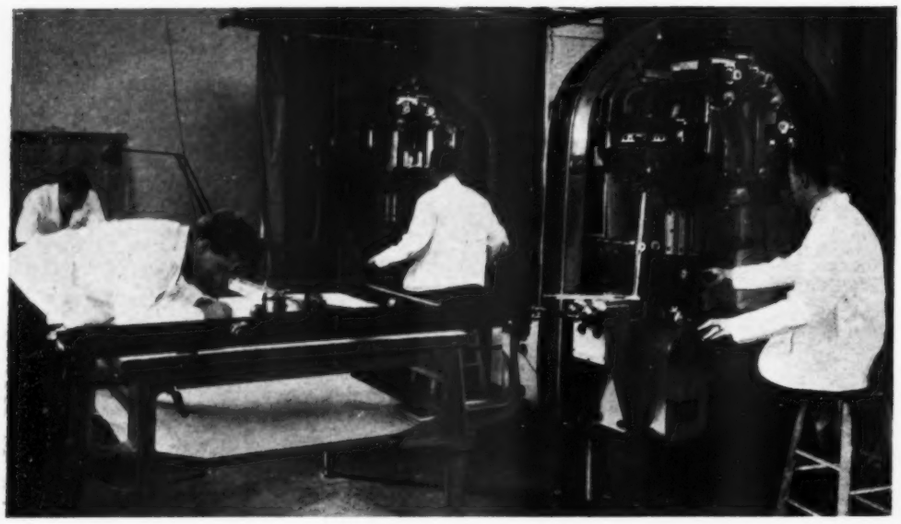
A resources survey of an undeveloped area usually divides itself into four stages as follows :

Stage 1. The collection and examination of all existing data concerning the area ; this may lead to the assignment of priorities in planning the survey.

Stage 2. Reconnaissance ; in which small-scale aerial photography is used to examine the entire area, to locate zones for immediate development and to prepare topographic maps for general planning.

Stage 3. Appraisal ; in which larger-scale photography is used to prepare inventory maps of potential resources.

Stage 4. Construction planning ; in which large-scale contoured maps are prepared by photogrammetric methods to



Stereo plotting instrument used for the preparation of large-scale plans and close contouring

be used in actual development operations.

An interesting sideline of development is the use of aerial data for the construction of scale models which can be employed in designing works and planning operations, which because of their three-dimensional character can supply a wealth of information in an easily understood way.

Apart from their use in developing new areas, aerial surveys can be used with advantage in revising existing maps and plans in the quickest and most complete way. This applies both to rural and urban conditions, their use, for example, in altering or redesigning the layout of buildings and fields on farms and estates finding increasing application.

Conclusion

In a brief account it is only possible to outline some of the main developments which have taken place in the development of aerial survey methods. It, however, suffices to indicate the great advances which have been achieved and the vast potentialities of the method in the future.

Acknowledgments

In preparing this paper free reference has been made to the monograph on the 'Use of Aerial Survey in Forestry and Agriculture,' by Mr. J. W. B. Sisam, published by the Commonwealth Agricultural Bureaux, to a paper by Mr. T. D. Weatherhead, O.B.E., M.A., general manager of Hunting Aerosurveys Ltd., recently read before the Royal Society of Arts, and to other technical literature. It is desired to acknowledge the help of Mr. Weatherhead in reading and revising the manuscript and permitting a visit to the laboratories of his company.

(*Right*) **Filling the drum hopper with seed for distribution on the mountainside** (*see below*)

Pioneer Aerial Seeding in Britain

AN instance of successful seeding by air of mountainside grazing which took place in the U.K. has been described to us by Mr. David Miln, a well-known Chester seed merchant.

The problem was to re-seed a mountainside on a slope of 60°, which made it virtually impossible to use land machines ; horses, however, could be used. The first operation was to remove the natural vegetation of heather and bilberry scrub and uproot as much of the bracken as possible.

During the autumn previous to the spring in which the seed was sown, the bilberry and heather had been burnt off, but not too close to the ground so that soil would not be sterile, and a dressing of 10 cwt. of basic slag and 4 cwt. of nitrochalk had been applied.

Although horses could be brought to the site the land was too rough to take a plough and the only cultivation implements used were harrows. Following this, a soil analysis showed the soil to be in poorish condition, and so an application of basic slag at the rate of 8 cwt. per acre and ammonium phosphate at 4 cwt. was carried out.

This was done during April, and two days after fertilising rain came, putting the soil into a condition most suitable for receiving the seed mixture, which was to be dropped from an Auster aircraft.

An exhaust-shaped spout had been designed to project beneath the fuselage and above it a drum-hopper contained the seed. A seed mixture was used consisting of :

15% Italian Ryegrass (for early bite).
34% Early Flowering Perennial Ryegrass.
25% Late Flowering Perennial Ryegrass.
20% Shelled Blended Cocksfoots.
6% Blended White and Wild White Clovers.

This mixture was sown at the rate of 65 lb. per acre.

Weather conditions were good, the wind speed was only about 5 m.p.h. and distribution proceeded according to plan.

A check was made after the first run of the aircraft which showed that the method employed was working satisfactorily. Ground signalling strips were not necessary for the low altitude at which the plane was flying ; manual signals were sufficient. The plane returned to its landing site at the bottom of the mountain after each binful had been distributed.

Further cultivation consisted of a light harrowing, all that was possible under the circumstances. It was quite out of the question to roll the ground.

In due course the treated area was revisited and the success of the operation confirmed. This is the first time to our knowledge that air seeding has been carried out in the U.K., and the possibility of future work on similar lines is being considered. A picture showing the aircraft being loaded with seed is published above.

Measuring Efficiency of Topdressing by Light Aircraft

P. B. LYNCH

Crop Experimentalist, Department of Agriculture, Wellington, New Zealand

In New Zealand aerial topdressing has developed rapidly as a commercial proposition. By the end of July 1950 some 20 private operators had distributed 11,600 tons of superphosphate over 116,000 acres. The efficiency of the operation is obviously important, and to test this a series of experiments was carried out recently in New Zealand, of which an account is given below.

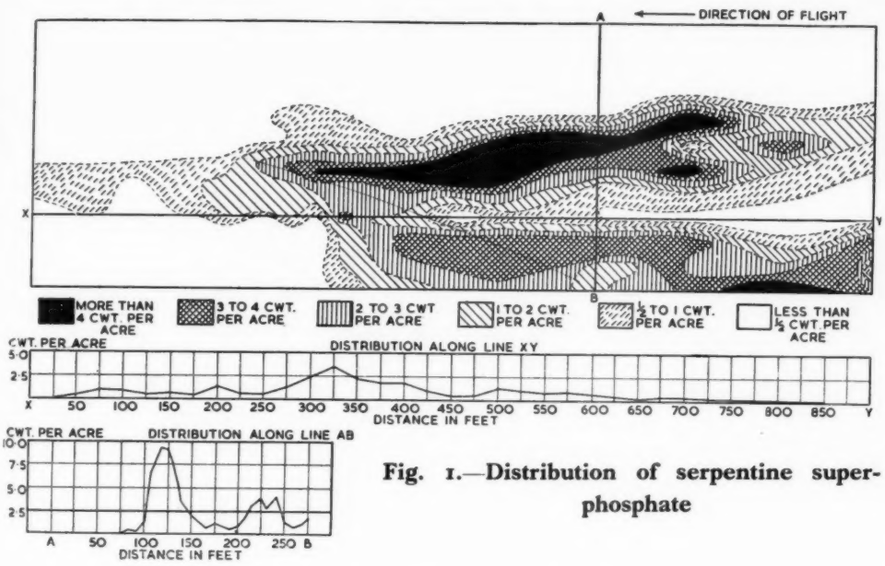


Fig. 1.—Distribution of serpentine superphosphate

TABLE 1. DISTRIBUTION PATTERNS OF THREE FERTILISERS

Fertiliser dropped	*Amount dropped (cwt.)*	*Area of target (acres)*	**Area receiving more than ½ cwt. per acre (acres)*	**Mean density (cwt. per acre)*	
				on target area	*on area receiving more than ½ cwt.*
Serpentine superphosphate	12.8	5	2.8	1.3	2.2
Superphosphate	12.8	5	3·7	1.2	1.6
Granulated superphosphate	12.0	5	3·4	1.3	1.9

* Figures not corrected for losses caused by fertiliser bouncing out of boxes

TABLE 2. PERCENTAGES OF COLLECTING BOXES IN VARIOUS DENSITY ZONES

**Zone*	*Serpentine superphosphate*	*Superphosphate*	*Granulated superphosphate*
0 to ½ cwt. per acre	43	29	22
½ to 1 cwt. per acre	16	18	9
1 to 2 cwt. per acre	14	29	24
2 to 3 cwt. per acre	6	18	13
3 to 4 cwt. per acre	11	3	16
More than 4 cwt. per acre	10	3	16

* Figures not corrected for losses caused by fertiliser bouncing out of boxes

EFFICIENCY of distribution of fertilisers spread by light aircraft appears from observation to be very satisfactory in most cases. However, observational methods of judging distribution are liable to serious error, and it was considered desirable to undertake measurements of spread in a series of trials. Because light aircraft operate without the assistance of 'ground control' the efficiency of fertiliser distribution from them must depend to a considerable degree on the skill of the pilot. This fact must be considered when the results of the trials are examined, and probably many commercial operations would give less efficient distributions than those which have been measured. To form some idea of this variation an attempt was also made to measure with less precision a large-scale application. In both the detailed and the commercial trial a highly experienced pilot was operating under reasonably good flying conditions.

Conduct of detailed trials

The detailed measurement trials were conducted on the property of Mr. H. Johnstone, Whatawhata, Waikato, on April 18 and 19, 1950, in conjunction with the James Aviation Co. One aircraft was used and the measuring area was in each case traversed by four runs of each of three fertilisers: ordinary superphosphate, granulated superphosphate and serpentine superphosphate. Collecting boxes were placed in a 'grid' of 11 rows of 12 boxes each, the boxes being 24 ft. apart in the rows, and the rows 100 ft. apart. In addition to this grid, extra boxes were placed in one longitudinal line at 25-ft. intervals and in one transverse line at 8-ft. intervals. The total measured area was therefore 1,100 ft. by 288 ft., or about 7½ acres, and the flight lanes averaged about one chain apart.

Instead of the normal load of about 570 lb. of fertiliser, the loads dropped on the measuring area were 373 lb. of superphosphate and serpentine superphosphate and 336 lb. of granulated superphosphate for each of the four runs. This was done to fit in with the area available for measurement. The aircraft was operating under normal conditions of loading for commercial distribution and accurate sampling of the material distributed was not possible.

The wind at the time of the trials was light at ground level, but the pilot estimated it at between 8 and 20 m.p.h. at the altitude of the aircraft, 70 ft., and blowing approximately at right-angles to the lines of flight. The speed of the aircraft was 80 m.p.h.

Tables 1 and 2 summarise the results of these trials.

Serpentine superphosphate

Distribution patterns for the serpentine superphosphate spread on the afternoon of April 18, 1950, are shown in Fig. 1. Obviously the wind displaced this fertiliser to one side of the measuring area and a considerable amount fell outside the area, despite the efforts of the pilot to allow for wind drift. Some of the serpentine superphosphate fell from the aircraft in relatively large lumps.

The main area of heavy concentration of fertilisers probably results from a mixing of the larger particles, which fall almost straight down, from one run with the smaller particles which have drifted with the wind from the adjacent run. The total measured target area to receive fertiliser was nearly 5 acres, but this is an underestimate, for no account can be taken of the fertiliser falling outside the fence line.

On the 5 acres on which fertiliser fell the mean density as measured was 1.3 cwt. per acre. An attempt was made to identify flight lanes from a detailed study of the distribution pattern and to estimate the percentage of fertiliser measured in relation to that taken up by the aircraft. On the area receiving more than ½ cwt. per acre only 62% of the fertiliser dropped was accounted for. Some of this loss was caused by fertiliser bouncing out of the collecting boxes and some by fine dust drifting out of the target area. Canvas catchers were not used in these trials because of the proportion of fine material in superphosphate and serpentine superphosphate which tends to lodge in canvas and cannot be removed satisfactorily for weighing.

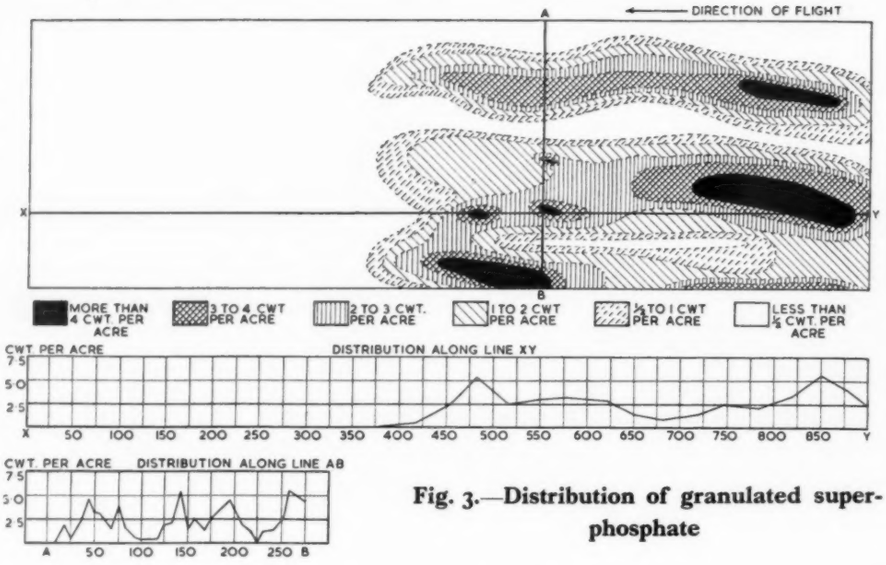

DIRECTION OF FLIGHT
A
B
X
Y
MORE THAN 4 CWT. PER ACRE
3 TO 4 CWT PER ACRE
2 TO 3 CWT. PER ACRE
1 TO 2 CWT PER ACRE
½ TO 1 CWT PER ACRE
LESS THAN ½ CWT. PER ACRE
CWT. PER ACRE
DISTRIBUTION ALONG LINE XY
7·5
5·0
2·5
X 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 Y
CWT. PER ACRE DISTRIBUTION ALONG LINE AB
7·5
5·0
2·5
A 50 100 150 200 250 B

Fig. 3.—Distribution of granulated superphosphate

The area receiving more than ½ cwt. per acre was 2.8 acres as measured by the distribution graph. On this area the mean density was 2.2 cwt. per acre. These figures are all under-estimates of the true density, but the variations in the distribution pattern give a reasonably accurate picture of the type of spread obtained.

Superphosphate

The distribution with superphosphate is shown in Fig. 2. Again the displacement of material to one side of the measuring area is evident. The graphs differ from those for serpentine superphosphate in that the areas of heavy deposition are very small and it is practically impossible to identify the flight lanes from the distribution pattern.

The mean density over the area receiving fertiliser (again about 5 acres) was 1.2 cwt. per acre, but by estimating the probable pattern outside the measuring area it was found that only 46% of the fertiliser dropped from the aircraft was accounted for in the collecting boxes. Though the accuracy of this figure is open to question, probably more straight superphosphate than serpentine superphosphate drifted well away from the collecting area in the form of fine dust.

The area receiving more than ½ cwt. per acre was 3.7 acres, as measured by the distribution graph, and the mean density on this area was 1.6 cwt. per acre. Again, all these figures are under-estimated to a considerable degree.

Granulated superphosphate

The distribution with granulated superphosphate is shown in Fig. 3. This material was imported from England for the trials and had a particle size mainly within the range of 9/64 to 12/64 in. diameter ; 7% was larger than 12/64 in., and 27% passed through a 9/64 in. sieve. There were a few aggregations of granules, which separated easily with pressure from the fingers. It flowed much more rapidly than the superphosphate or serpentine superphosphate, with the result that the last third of the grid did not receive fertiliser because the hopper was empty ; that could be avoided by adjusting the size of the delivery hole of the hopper.

The distribution pattern for granulated superphosphate shows clearly that the fertiliser fell where it was intended to fall. Though the wind was stronger in this trial than in those with the other two fertilisers, there was no marked displace-

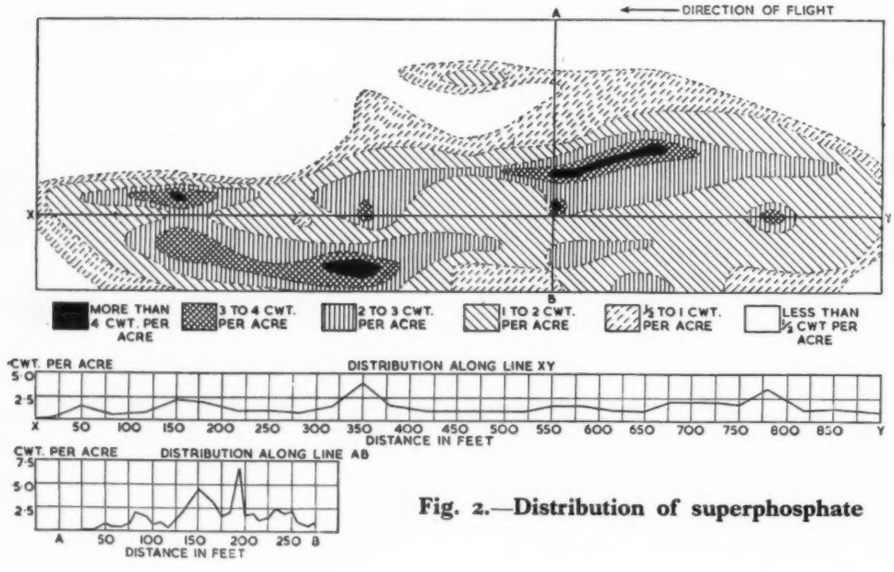

DIRECTION OF FLIGHT
A
B
X
Y
MORE THAN 4 CWT. PER ACRE
3 TO 4 CWT. PER ACRE
2 TO 3 CWT. PER ACRE
1 TO 2 CWT. PER ACRE
½ TO 1 CWT. PER ACRE
LESS THAN ½ CWT PER ACRE
CWT. PER ACRE
DISTRIBUTION ALONG LINE XY
5·0
2·5
X 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 Y
DISTANCE IN FEET
CWT. PER ACRE DISTRIBUTION ALONG LINE AB
7·5
5·0
2·5
A 50 100 150 200 250 B
DISTANCE IN FEET

Fig. 2.—Distribution of superphosphate

Looking uphill across the line of flight sited from the tree in the centre to the tree on the horizon

TABLE 3. DISTRIBUTION OF SERPENTINE SUPERPHOSPHATE AND SUBTERRANEAN CLOVER SEED

Rows of collecting boxes down ridges							
First row		*Second row*		*Third row*		*Transverse row*	
Weight of fertiliser (cwt. per acre)	*Number of seeds per box*	*Weight of fertiliser (cwt. per acre)*	*Number of seeds per box*	*Weight of fertiliser (cwt. per acre)*	*Number of seeds per box*	*Weight of fertiliser (cwt. per acre)*	*Number of seeds per box*
0.3	1	0.7	Nil	1.0	Nil	0.7	1
—	—	0.8	Nil	—	—	—	—
0.6	1	0.8	Nil	0.7	Nil	—	—
—	—	0.7	Nil	—	—	0.8	3
1.4	8	0.7	Nil	0.8	Nil	—	—
—	—	0.5	Nil	—	—	—	—
1.6	1	0.3	Nil	0.7	1	0.9	4
—	—	0.3	Nil	—	—	—	—
0.5	Nil	0.7	2	0.7	1	—	—
—	—	1.1	1	—	—	1.8	5
2.8	3	0.6	1	0.6	Nil	—	—
—	—	0.8	Nil	—	—	—	—
1.8	Nil	0.6	Nil	0.5	1	0.6	Nil
—	—	0.7	Nil	—	—	—	—
2.1	6	0.8	3	1.5	Nil	—	—
—	—	0.9	Nil	—	—	0.6	3
0.5	1	0.7	Nil	2.0	3	—	—
—	—	0.8	2	—	—	—	—
0.6	1	0.7	2	1.5	4	0.3	Nil
—	—	0.6	1	—	—	—	—
1.3	4	0.6	2	0.5	Nil	—	—
—	—	0.6	2	—	—	0.8	3
2.3	2	0.8	5	0.7	1	—	—
—	—	1.1	4	—	—	—	—
4.1	3	0.9	3	1.1	Nil	1.0	1
—	—	1.5	6	—	—	—	—
3.0	1	1.4	1	1.5	1	—	—
—	—	1.5	2	—	—	0.4	3
2.4	1	1.5	2	2.2	2	—	—
—	—	2.3	2	—	—	—	—
1.4	3	2.5	3	1.4	Nil	1.0	2
—	—			—	—	—	—
1.5	1			1.5	Nil	—	—
—	—			—	—	0.7	1
0.1	Nil			2.7	3	—	—
—	—					—	—
0.5	4					0.8	Nil
—	—					—	—
1.3	7					—	—
—	—					0.5	Nil
Nil	Nil					—	—
						0.3	Nil

ment caused by wind. The two central runs overlapped somewhat and the drop from the first run fell right on the boundary of the measuring area. The granules could be seen very easily on the ground and they extended about four yd. outside the measuring area.

Though the distribution of granulated superphosphate was in definite bands, it is apparently much more controllable than superphosphate, and the area covered was very regular in pattern.

On the 5 acres of the target area a mean density of 1.3 cwt. per acre was obtained. Because it was possible to identify a single run with precision, it can be said that 43% of the pellets bounced out of the boxes. Correction for this and the knowledge that the loss in dust form is negligible, increases the mean application rate to 2.3 cwt. per acre and the figures for the distribution graph should be increased by 77%. The loss by bouncing is very much higher with granulated material than with powdered fertilisers like ordinary superphosphate.

With granulated superphosphate it is possible to identify flight lanes on the distribution pattern and consequently the mean widths of swathes of the fertiliser can be calculated.

They were :

Corrected density per acre	*Mean width of fertiliser swathe*
1 cwt. and greater	65 to 70 ft.
2 cwt. and greater	60 ft.
4 cwt. and greater	40 ft.

In all cases the longitudinal graphs show that there is no regular change in the amount of material released as the run is made.

Commercial trial

To enable some idea to be formed of the distribution that might be expected in a commercial operation, catchers were placed on a steep hill-face on the new hill country station of the Ruakura Animal Research Station, and serpentine superphosphate at 2 cwt. per acre with subterranean clover seed at 2 lb. per acre was distributed from the aircraft as part of a normal commercial operation.

The general layout of the collecting boxes was in three lines down ridges and one line traversing ridges and gullies. The boxes on the outer ridges were 8 yd. apart, in the centre row 4 yd. apart, and in the transverse line 12 yd. apart. The weight of serpentine superphosphate (calculated as cwt. per acre) and the number of subterranean clover seeds collected in each box are shown in Table 3. The figures have been arranged to indicate intervals of 4 yd. and the boxes each collect an area of $1\frac{1}{2}$ sq. ft.

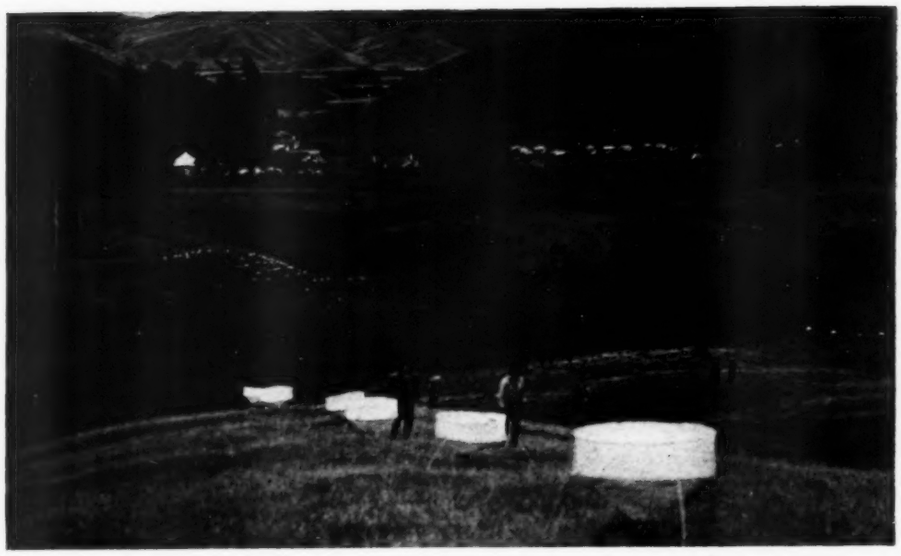
It is clear that an exceptionally good distribution of both fertiliser and seed was obtained in this trial.

Averages of granular material

Measurements of distribution of three fertilisers from light aircraft have shown that a high standard of efficiency can be achieved by an experienced pilot. For precision dropping a granulated material is necessary, but with large-scale applications any drift of fertiliser down wind can be compensated by the overlapping effect from parallel lines of flight with fertilisers containing much fine material.

Furthermore, if aircraft have to fly much higher than 100 ft. above the ground, probably a granular material will be essential to ensure that most of the fertiliser will fall on the area where top-dressing is desired.

(*New Zealand Journal of Agriculture*, April 1951, 82, 4, pp. 315-320.)



Canvas check traps were 1 sq. yd. in area, arranged in parallel lines over part of the course. From the pellets recovered it was possible to calculate distribution per acre and the effect of wind deflection

Photos: pp. 475 and 476 High Commissioner for New Zealand.

Helicopter Spraying Improves Marshland

DURING the last two years experiments have been carried out by Pest Control Ltd. on the spraying of marshland from the air with a chemical which is a mixture of weedkiller and fertiliser. That the improvement which has been effected by killing the weeds and encouraging the grasses is remarkable can be seen from the accompanying photographs.

In June 1950, at a public demonstration in Norfolk, 8 acres of marshland were sprayed at Acle and 8 acres at Ingham. It was done on a very wet day and, had it not been that numbers of people had come along, the spraying would have been postponed.

A mixture of Phenoxylene 30, the plant hormone weedkiller, and a fertiliser consisting of superphosphate and sulphate of ammonia was applied as a liquid spray at a dosage rate of between 5 and 6 gal. per acre.

On Mr. G. M. Deane's land at Ingham there were two 8-acre marshes divided by a dyke. Both had been ploughed and re-seeded, one in 1943 and the other in 1944. By 1950 both were so covered in weeds — particularly rushes — that the grasses had been almost completely crowded out and it seemed that the ploughing and re-seeding would have to be repeated. At the suggestion of Pest Control Ltd. Mr. Dean agreed to have one marsh sprayed with manurial Phenoxylene while the other was left untreated to act as a control.

By the summer of 1951 the sprayed marsh was almost free of rushes and had a close sward in which clovers, rye grass and timothy predominated. Good grazing had been provided for quite large numbers of cattle for two and three weeks at a time. Next to it the unsprayed marsh was so dense with rushes and other weeds that its value as a pasture has been almost nil. The ploughing and re-seeding of the sprayed marsh need not now take place for two or three years and, if the marsh were to be sprayed again next year, would be postponed indefinitely.

At Acle, where only one-half of the marsh was sprayed, the results are equally good, although not so spectacular because the predominant weeds were thistle and buttercup.

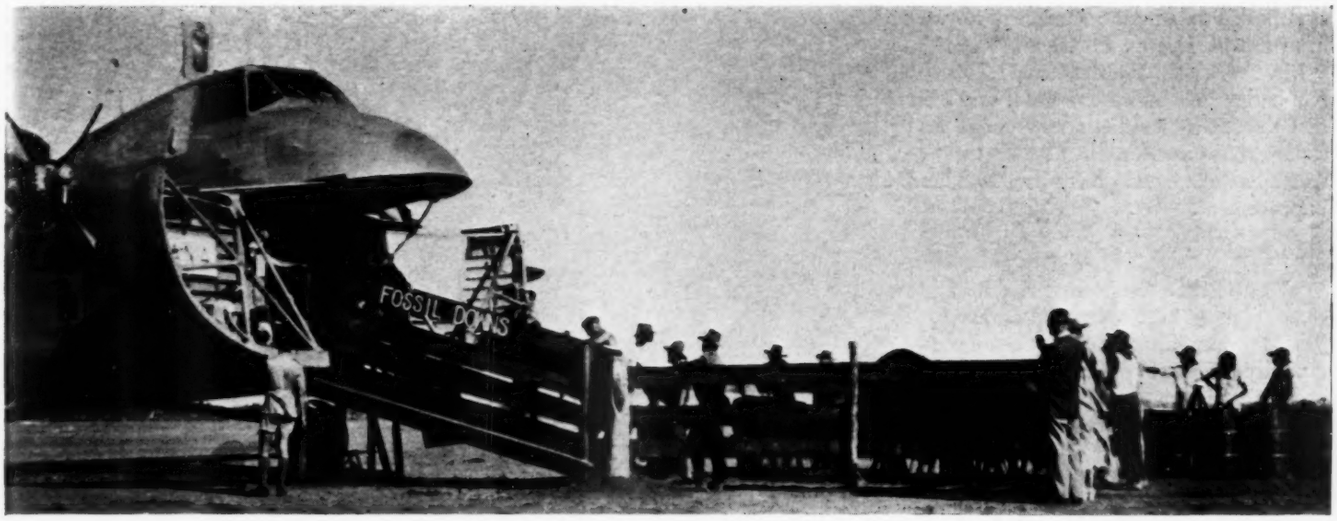
The effect, however, is the same. The kill of weeds is not 100% but it is very high, and the grasses, stimulated by the fertiliser and finding the competition of the weeds removed, have established themselves well.

Following the success of the 1950 small-scale experiment, over 1,000 acres of marshland have been sprayed in East Norfolk this summer.

In this area alone there are 30,000 acres of marshland that would benefit from the weedkiller/fertiliser spray and about half of this acreage could not be sprayed by ground machines owing to lack of roads and inadequate bridges over the dykes. Spraying from the air is the solution, but it is not a makeshift one. With large areas to be covered, it would be slow and laborious work for even the biggest ground machines, whereas a helicopter can cover hundreds of acres a day at a cost of £3 10s. 0d. to £4 an acre.

Thus the helicopter has a large part to play in improving marginal land.

(*Top*) **Untreated marshland at Ingham, Norfolk.** (*Bottom*) **Treated marshland at the same place which has been sprayed with manurial phenoxylene**



Stud cattle being loaded aboard a Freighter at Fossil Downs cattle station in the Kimberleys

Air Transport of Agricultural Produce in Australia

THE vast area of Northern Australia known as the Kimberleys, is potentially one of the richest cattle-producing areas in the world, but its development has been hamstrung by the impossibility of providing adequate land communications at economical cost. The only means of bringing cattle to the shipping centres was to drive them hundreds of miles over arduous stock routes to coastal abattoirs, but even in the best of seasons the stock routes took a heavy toll.

The employment of air transport for agricultural produce and machinery is another modern development of the use of aircraft. In no country is this more evident than in Australia, where conditions have led to the rapidly increasing use of aircraft in this connection.

Air transport of beef

As long as 15 years ago the idea of an 'Air Beef' organisation was discussed, but not until 1947 did the plan reach the stage of practical trial. Even then, no more than a crude experiment was attempted.

In 1949, the scheme was given shape by the formation of Air Beef Ltd. Financial encouragement was given by the State Government, and the establishment of a centre was begun at Glenroy.

All machinery, plant and buildings needed for the slaughter house, chilling chambers and domestic quarters was taken out by air. The airstrip itself cost only £100 to construct, the 8,000 ft. runway being simply scraped out of the flat land.

During 1949, 1,800 beasts were slaughtered at Glenroy and the meat flown to Wyndham, 180 air miles to the south-west. There were many set-backs and difficulties, but the experiment was sufficiently successful to lead to enormous development in 1950.

One major improvement was the introduction of the Bristol Freighter. The nose-loading doors were an immeasurable advance on the side-loading facilities of earlier aircraft, and the aircraft was able to operate from the existing airstrip with a load of nearly six tons, equal to about 20 carcases.

The 1950 season

The 1950 target was set at 4,500-5,000 beasts and, to handle this greatly increased number, slaughter house capacity, chilling space, equipment and staff accommodation were expanded.

The killing season began early in May. At first, the abattoirs handled about 100 beasts a week, but before the end of the season they had reached their capacity of 300 cattle per week.

What the Air Beef organisers had first to prove was that, once beef had been chilled to the correct temperature, it could be transported in an unrefrigerated aircraft to a coastal cold storage centre without deterioration in appearance or quality. Practical operation proved this contention beyond all shadow of doubt; in fact, on many occasions Glenroy beef was up-graded by the second Commonwealth meat inspector who checked all the meat on arrival at Wyndham.

The abattoirs worked a five-day week, the Freighter making two flights a day to Wyndham, carrying some six tons of beef on the outward trips and returning with a back-load of operating supplies, equipment and mail. In all, the aircraft carried 2,062,304 lb. of beef and 155,420 lb. of hides and flew 82,412 miles in 588 flying hours.

Other developments

Pig-raising began at Glenroy as a side-shoot of the Air Beef scheme. In 1950 an early opportunity was taken to fly in 70 pigs for fattening and, later, two boars and about 100 sows for breeding purposes. A small killing was made at the end of the season, and 5,439 lb. of pork were flown out.

Most notable example of livestock transport, however, was a cargo of 20

stud bulls flown by the Air Beef Freighter from Fossil Downs to Glenroy.

Mr. W. N. M. MacDonald, of the Kimberley Poll Shorthorn Stud, said later that the flight heralded a new era of stud cattle transportation in the north of Australia and should greatly facilitate herd improvement.

The outlook

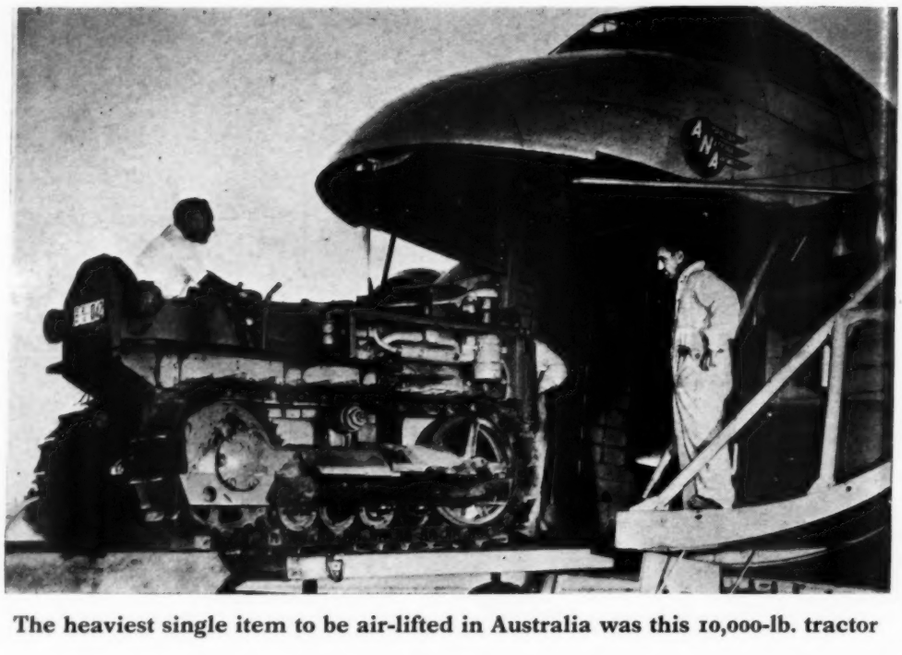
There is little doubt that Air Beef has come to stay in Northern Australia. It has not only improved the quality and quantity of beef produced by existing properties, but it has shown that there is ample scope for new settlers. The area of the Kimberleys is vast and very sparsely populated.

The needs of the export market and of Australia's own growing home market ensure a constant sale for all the meat that Northern Australia can produce. An extensive survey has already been made for potential expansion and plans for a new abattoir at Hall's Creek are under consideration ; it is hoped that the abattoir will be operating for the 1952 season.

Other developments

Side by side with and subsequent to the above there have been other important air freight developments in Australia.

The Australian National Airways experts have long argued that air transport was often the most economical way of getting goods to market. Although rates are higher than for surface transport, they claimed that the additional cost was offset by the saving in time, elimination of wharfage and handling charges and reduced risk of damage or deterioration in transit. But although a few very perishable items like flowers were consigned by air, the bulk of Australian farmers remained unconvinced.

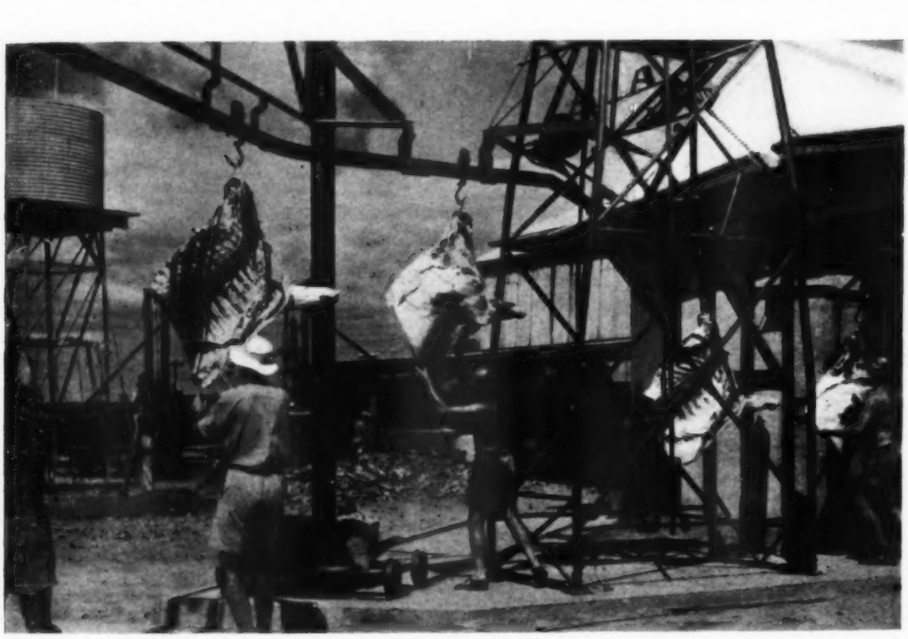


The heaviest single item to be air-lifted in Australia was this 10,000-lb. tractor

Then came a series of labour troubles which disrupted sea and rail services, and aircraft became the only reliable means of long-distance transport.

Fruit and vegetable freight

Farmers began to send their produce by air and found the service so worthwhile that, when normal surface facilities were restored, many kept up air shipments. Fresh beans, peas and strawberries were flown south from Brisbane in increasing quantities, becoming a feature of A.N.A.'s regular freight traffic. One shipper alone sent 25 tons of strawberries by air during the season. This year most of the high-grade beans on sale in Melbourne shops had been flown from Brisbane and South Queensland. Bought by the housewife at 1s. 6d. or 2s. per lb., they had probably incurred a bulk of air freight charge of about 6d., whereas they could have gone by rail for half the cost. But the rail journey would have taken two days and the crisper, fresher, air-freighted article commanded a definite premium on the market, justifying the additional cost.



Loading carcasses aboard a Freighter at Glenroy abattoir, Australia. The quartered carcasses are taken from the cold store by conveyor to the aircraft

Transport of agricultural machinery

Even so, the 'vegetable air-lift' was confined to comparatively small loads, which could have been handled by almost any aircraft. A.N.A., using three Bristol Freighter aircraft, had built up a profitable traffic in heavy items of machinery, road vehicles, road-making equipment and so on. They claimed that the Freighter had 'taken air cargo out of the luxury field into that of straight utility transport'. Chance once again stepped in to provide an opportunity for the airline to bring the lesson home to the farmers.

The Australian summer of 1949-50 brought a spell of freak weather in New South Wales. Ten days of heavy rain were followed by temperatures of 100° and more. Apricot crops ripened far ahead of schedule, and growers worked overtime to pick and pack the fruit for the canning and

jam factories. But the manufacturers were taken unawares by the early crops. Machinery essential to the processing of the fruit could not be obtained because of rail strikes, and for a time it looked as though much of the crop would be wasted. Something had to be done quickly, and the canners turned to A.N.A. for help.

Switching a Freighter to the task, A.N.A. flew the urgently needed machinery north. In one case, a Victorian firm of jam-makers who had opened a new factory in another state were faced with a stoppage in production because they could not transfer apricot-stoning equipment from the parent plant. A.N.A. sent a 3-ton truck to the Victoria works in the late afternoon, unscrewed the machine from its base and rushed it to Essendon Airport, Melbourne, where it was loaded onto a waiting Freighter. The aircraft flew the machinery 500 miles to its destination, where it was transferred to another truck and delivered to the factory late the same night. By 8 a.m. the next day production was once more under way.

Another ' canning ' load was a consignment of 4 tons of machinery flown to Devonport, Tasmania. It comprised a syruper and sealing machine measuring 6 ft. 10 in. by 3 ft. 3 in. by 5 ft. 10 in. and weighing 1 ton, and a 3-ton exhaust box 20 ft. long and 6 ft. wide by 4 ft. high.

Conclusion

These were emergency operations, but the service provided by A.N.A. convinced Australian food producers that the Freighter had much to offer them. Today the airline is handling scores of items which no one would have dreamed of air-freighting three or four years ago. Not a little of its traffic comes from Commonwealth farmers, who now unhesitatingly send by air consignments of such things as seedlings, baled wool, pedigree cattle and sheep, and vegetables, as well as farm tractors and other machinery. When aircraft carried only such items as flowers or urgently needed drugs, it could be said with some truth that they were merely skimming the cream off surface transport traffic. Today, in the words of A.N.A.'s Ian G. Webster, they are ' delving deeper and deeper into lines that have little or no cream to distinguish them.'

Photos : Bristol Aeroplane Co. Ltd.

Insecticidal Smokes for Disinfesting Aircraft

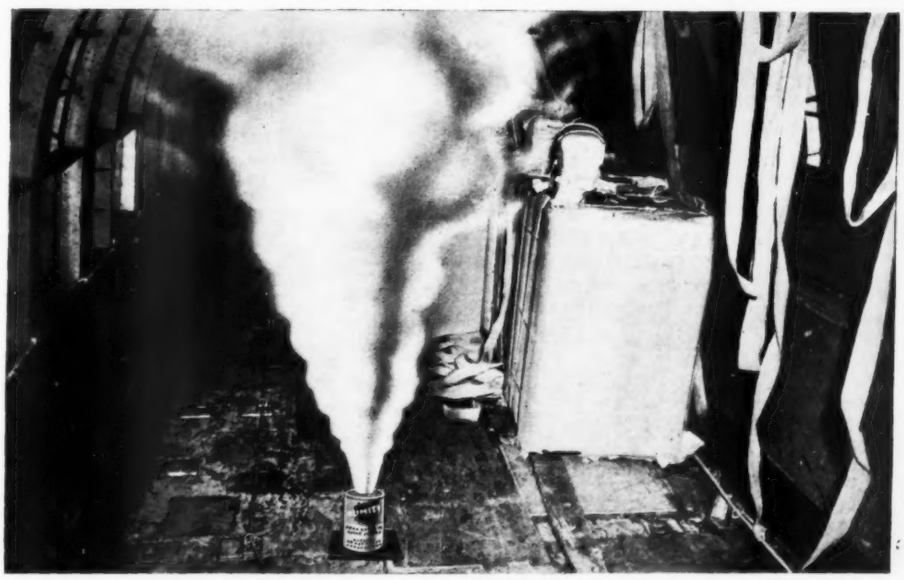
LONG distance aircraft, like long distance shipping, are apt to become infested by insects of sub-tropical or tropical origin, such as the mosquito.

Freight-carrying aircraft are also likely to become infested by a wide variety of other insect pests brought in with infested cargo, and there is, of course, the risk that an originally clean aircraft may become contaminated and be the prime cause of contamination of a valuable commodity carried in it later.

Smoke generators, of Fumite type, made by Messrs. Waeco Ltd., of Salisbury, Wilts, are now available, and these are suitable not only for disinfesting aircraft but for keeping them free from further infestation for considerable periods of time. These generators are designed to liberate DDT or benzene hexachloride individually or simultaneously if desired, in the form of microscopic particles which are so small that they have the appearance in bulk of a dense cloud. In a closed aircraft these fine insecticide particles behave much as if a true gas were involved, and will diffuse into all available space.

There is no need to arrange the cargo in any special way for treatment, for providing there are some spaces between individual pieces, the insecticide will be automatically carried there by natural diffusion.

Treatment by smoke generators may be conveniently given at a night stop or at a stop for refuelling, if the duration of the stay is some three to four hours, for by the end of this time practically all the smoke particles will have settled or will be attached to all exposed surfaces. The heaviest deposition will be found on the upper sides of all horizontal surfaces or those surfaces which project horizontal planes, and the concentration of the deposit will be uniform.



Disinfesting the inside of an aircraft with a Fumite-type smoke generator

After treatment, that is some three to four hours later, the aircraft can be opened up, ventilated, and ready for the next flight. Normal ventilation will not remove the insecticide deposit from the inside of the aircraft, and with DDT for example this will persist in active form for many months, depending upon the prevailing temperatures.

Recent research has shown that the efficiency of insecticides increases with reduction of particle size, and in this respect the insecticide particles automatically obtained from smoke generators are smaller than those which are attained by other means at such low cost.

It is normal practice to stand the generator on a piece of tile or inside a metal container whilst functioning.

Some very interesting experiments were conducted in the London area some few months ago in which it was demonstrated that Fumite type smoke generators can be made to function satisfactorily under water. This opened up new possibilities in that kindled generators can be tossed onto normally inaccessible swampy ground or stagnant pools—the natural breeding places for mosquito. The liberated insecticide rises to the surface of the water and forms a thin enveloping scum.

More extensive exploratory trials are being conducted in Africa at the present time. This is a development in which the aircraft will be able to co-operate at a later stage in that it will provide the means of placing generators precisely where they are required.

FARM MACHINERY

THE SMITHFIELD SHOW

The Smithfield Show and Agricultural Machinery Exhibition is to be held at Earls Court, London, from December 3 to 7. Since we go to press with this issue before the Show commences, we publish below a preview of some of the machinery and equipment which visitors will have an opportunity of examining during show week. Next month we hope to publish an account of the Show itself.

Introduction of Plastic Hosing

The plastics industry, whose range of products extends to most branches of industry, has now entered the agricultural field with the advent of the plastic hose. This new hose material weighs less than half that of average rubber hose, yet will stand working pressures up to 600 lb./sq. in. and bursting pressures more than double this. It is reported to be chemical resisting up to 65° C., and can be jointed by the heat of a tractor exhaust. This new material, which promises to be revolutionary, will be shown for the first time at Smithfield by Messrs. Drake and Fletcher Ltd., on stand 60.

The ' Mistifier ' knapsack sprayer, introduced during the past summer, will also be exhibited here. Knapsacks of the pressure-retaining type (once pumped up the same air remains in the machine and does the work for several months) are now being used on tea plantations, etc., where access is difficult owing to close planting. The latest method of keeping a large number of these machines charged with liquid is by using them in conjunction with a Kingston 11 pump and D and F plastic hose. The pump is located at the source of water supply and delivers mixed wash at pressure to a battery filling point some hundreds of feet away, close to the operators. Several knapsacks are filled at one time, and the operators unload their empty knapsacks and take away full ones, thus saving time and labour.

The price of the knapsack is now £16 15s. 0d. retail.

For Orchard Spraying

Messrs. Universal Crop Protection Ltd., whose products are well known on overseas markets, are this year showing on their stand No. 347 at the Smithfield Show such of their range of agricultural chemicals and spraying and dusting equipment as they think will be of interest to farmers, fruit growers and spraying contractors.

Amongst the equipment being shown will be the Whirlwind ' Professor,' a large tractor-drawn machine of revolutionary design on show for the first time. It has been designed specially to meet the needs of orchard-spraying contractors, being capable of carrying out spraying, dusting and wet dusting. Although the dusting side is similar in principle to that employed in their other equipment, the spraying side is of an entirely new design.

Two of the new features incorporated are controls to adjust both the ' throw ' of the spray and the quantity of liquid being applied whilst the machine is in operation. The droplet size remains constant at 40 to 120 microns.

Latest test reports state that the maximum effective horizontal ' throw ' is 120 to 140 ft. and the vertical ' throw ' 60 to 65 ft. It should therefore be capable of undertaking any spraying or dusting operations which are normally required.

Also on show will be the latest model of the Whirlwind ' Junior ' duster, a small machine which should prove popular in potato-growing areas for the application of copper fungicide dusts.

Overseas Visitors

We are informed by the Agricultural Engineers Association that a reception room and lounge will be available at Earls Court for overseas visitors during the Show. It will be staffed by experts to deal with any kind of enquiry and interpreters will also be available.

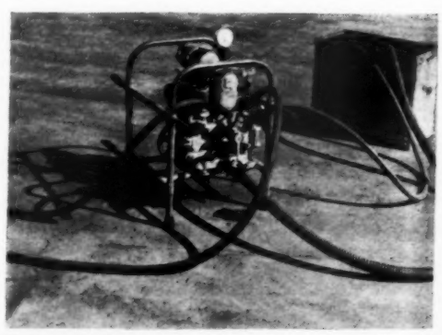
Another facility for overseas visitors, which has been much appreciated in the past, is the issue of free season tickets on request.

The staff of The British Agricultural Machinery Manufacturers' Export Association will be on duty in the Overseas Visitors' Lounge and it is hoped that Overseas Buyers will get in touch with the Association representatives, who will give every assistance in both advising and in directing the buyer to the firms who will most readily supply his requirements.

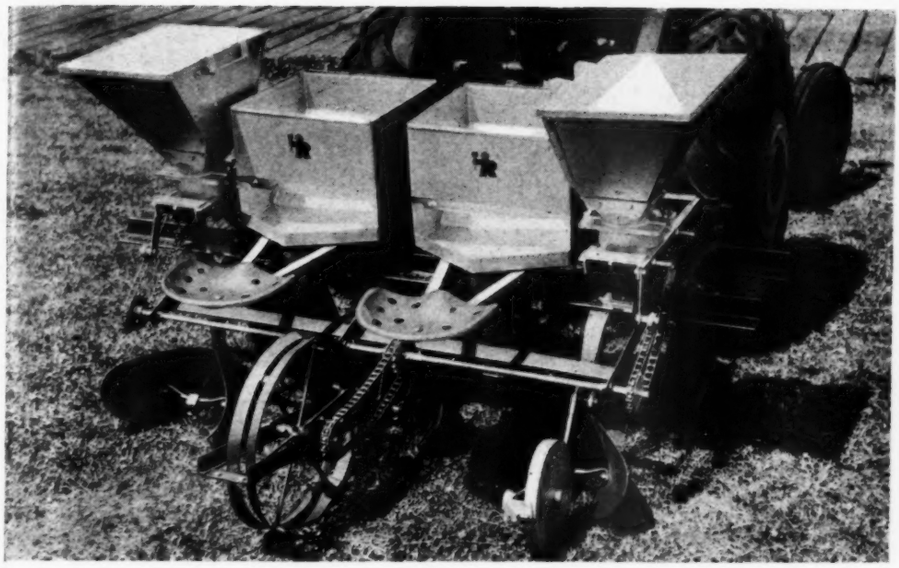
B.A.M.M.E.X. has played a leading part in the Agricultural Machinery Export Trade of this country for some years.

Mr. H. J. Lloyd, O.B.E., the chairman, is one of the Managing Committee of the Smithfield Show, and the staff have very recent and practical experience of farming both in England and overseas.

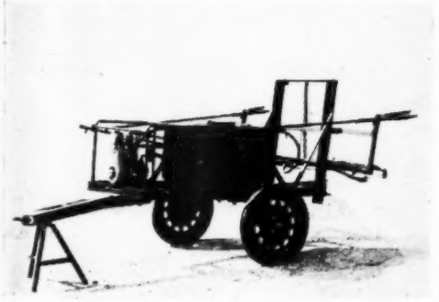
Universal Crop Protection's new whirlwind ' Professor ' spraying vertically to about 60 ft. high



(*Above*) **The Kingston 11 pump and D. and F. plastic hose which are used in conjunction with** (*below*) **Mistifier knapsack sprayers**



Two-row Robot potato-dropping attachment with the new fertiliser distributor attachment



Three Dorman sprayers. (*Top*) **250-gal. high and low volume ' de luxe ' model, 1952.** (*Centre*) **100-gal. high and low volume model with spring boom and anti-drip device, 1952.** (*Bottom*) **50-gal. low volume trailer sprayer**

Machinery for Spraying

The Dorman Sprayer Co. Ltd. are showing four sprayers at Smithfield, the 250 gal. high and low volume sprayer, the 100 gal. high and low volume sprayer, the 50 gal. low volume trailer sprayer and the 50 gal. Ferguson mounted low volume sprayer.

The first-named is an improved form of the Standard 250 gal. crop sprayer incorporating a new principle for simplifying the change-over from high to low volume. One spraybar is complete with high volume nozzles set at 9 in. centres and the other spraybar running parallel is complete with low volume nozzles set at 18 in.

The change-over is effected by a control lever on each sprayboom section (three in all) and printed thereon are three positions, ' High Volume ', ' Low Volume ' and ' Off '. The operator places the levers in the relevant positions and either increases or reduces the pressure by operating the pressure regulator valve to obtain the necessary application. For example, when applying DNOC, DNBP, etc., where 50 to 100 gal. per acre are required, the levers are set to ' High Volume ', the pressure regulator valve is adjusted to read 100 lb./sq. in. on the pressure gauge. Where the hormones are to be applied at low volume applications the levers are set at ' Low Volume ', the pressure regulator valve is opened out until 40 lb./sq. in. pressure are obtained and then the nozzle tips on the low volume side can be fitted to give the required low volume application (10, 15, 25 or 50 gal./acre).

The 100 gal. machine was placed on the market for the first time last year. To stress its simplicity pressure for both high and low volume applications remains the same at 60 lb./sq. in. For low volume applications of 5, 10, 15 and 25 gal./acre tractor speed is constant at 5 m.p.h. ; therefore the operator has only to become accustomed to one pressure and one speed, and each application is obtainable by fitting the relevant nozzle tips. To increase the application over 25 gal./acre a 50 gal./acre tip is supplied and the operator, to obtain 50 gal./acre, merely decreases his speed proportionately ; then by fitting the 50 gal./acre tips he can also obtain 100 g.p.a. by using the same method.

All these machines have been fitted with a new spring boom. Springs are incorporated at the boom support root to obviate any damage should the boom strike an obstruction or dig in ; it also saves any damage through boom whip. This is of particular importance for applications of non-corrosive haulm burners when travelling across potato rows.

Robot Machines

A fertiliser distributor for the two-row potato dropping attachment is the latest addition to the range of planting machines manufactured by Transplanters (Robot) Ltd., who will exhibit on stand 67.

This combine potato planter is designed to fit all power-lift ridgers. Fertiliser placement is controlled by the position of the delivery tubes and it can be mixed with the soil at the side, above or below the seed ; a thin layer of soil prevents direct contact with the seed. The two hoppers have a total capacity of 240 lb. and rate of application can be adjusted from 5½ cwt. upwards.

A variety of transplanters (trailer or power-lift models) will also be on show, including a unit implement for multi-row planting, suitable for single seeding of maize, sorghum, groundnuts, sunflowers, etc.

A sugar beet harvester that tops, lifts, cleans and elevates in one operation, the tops being windrowed and the beet conveyed by side-delivery elevator to a trailer, will be on this stand. Also a post hole digger for use with the tractor power-lift, capable of drilling holes 3 ft. deep with diameters of 6, 9 or 12 in.

Diesel Tractors

On stand 111 the Turner Manufacturing Co., of Wolverhampton, will exhibit four ' Yeoman of England ' diesel tractors together with a range of implements, including 1-, 2-, 3- and 4-furrow mounted ploughs. A new feature of the tractor is the incorporation of the Mark III diesel

engine which, it is claimed, provides a greater economy in fuel and running costs ; deep digging and 4-furrow ploughing can now be done with a Yeoman tractor working with Yeoman ploughs at a cost of 8d./9d. an hour.

The ' Dragon ' crawler tractor, which may be fitted with the Turner 4V95 engine, developing 36.5 b.h.p., will be exhibited on stand 74 by Vivian Loyd and Co. Ltd. This machine weighs just under $4\frac{3}{4}$ tons and has a maximum drawbar pull of 10,000 lb. (30 h.p. at the drawbar).

Vivian Loyd will also show a rotary motor sickle with alternative circular saw attachment. This is powered by a 98 c.c. Villiers two-stroke engine running on a petrol/oil mixture which drives the cutter head ; the sickle runs on two pneumatic tyres and is hand propelled.

Light Spraying Equipment

A comprehensive display of spraying machinery will be seen on stand 115 of Messrs. Cooper, Pegler and Co. In addition to knapsack sprayers, bucket sprayers, small hand sprayers and knapsack and rotary fan dusters there will be two power-operated machines. One is a 22 gal. model with $1\frac{1}{2}$ h.p. petrol engine and output of $2\frac{1}{2}$ gal./min. ; the other, a larger machine, has a 90 gal. tank and a three-cylinder pump giving an output of $5\frac{1}{2}$ gal./min., powered by a 3 h.p. engine.

The above firm have also developed a new low volume nozzle for use with all their sprayers, giving a flat or cone spray and varying outputs from 3 to 15 gal./hr. Its weight is $1\frac{1}{2}$ oz.

Manuring and Harvesting

Wild-Thwaite's forage harvester will be shown on stand 106 by Messrs. M. B. Wild & Co. for the first time at this show. This machine cuts, picks up, chops short and delivers pneumatically ; without the cutter bar it can be used to pick up from windrows. Only one operator, the tractor driver, is required and the clutch and adjustable pneumatic discharge are controlled from the tractor seat. The working width of this machine is 8 ft. 6 in. with cutter bar and 6 ft. 6 in. without cutter bar. The harvester's whole weight is 28 cwt.

Also to be seen on this stand will be the Wild-Thwaites muck spreader which straddles manure heaps and distributes at the rate of 20 to 25 acres a day.

A mechanical muck loader, too, is made by this firm and consists of elevator and power-operated fork. The latter is attached to the winch on the machine by a 40-ft. wire rope ; one man controls the fork and the other handles the clutch, applying power to the winch as required.

A tractor-mounted harvester-thresher designed for the farm with small fields will also be shown. A 40-in. threshing rotor is passed through the standing crop and the grain is passed through a cyclone and various cleaning stages before being discharged into a sack.

The Wild gang-seeder and Wild-Thwaite's power-operated sack hoist will also be exhibited.

New Rotavator Model

A machine, not previously exhibited, is the Howard Rotavator ' Gem ' Series IV, which will be seen on stand 85. Powered by an engine of Rotary Hoes' own construction, this is a new hand-controlled machine, having 810 c.c. capacity with 3 in. bore and $3\frac{1}{2}$ in. stroke ; it has three forward speeds and one reverse. The standard 24 in. rotor is centrally mounted and depth of cultivation is adjustable in half inch stages to a maximum (in most soils) of nine inches.

Also on stand 85 will be the Heavy Duty Rotavator Attachment, recently demonstrated in Suffolk as a land clearance and ' stubble busting ' implement (see WORLD CROPS, October 1951, p. 393), capable of carrying out rough cultivation at the rate of three to three and a half acres an hour.

Other exhibits will include a new compressor attachment for the ' Bantam ' Rotavator for operating small pneumatic tools, and the Howard Haulm pulveriser (winner of a silver medal at this year's Royal Show).

In Brief

We are informed that Messrs. Massey-Harris Ltd. will show the following machines on stand 77 at Earls Court : the standard model tractor (No. 744D), the No. 701 baler, the No. 712 farmyard manure spreader and two models, Nos. 717 and 718, of artificial manure distributors.

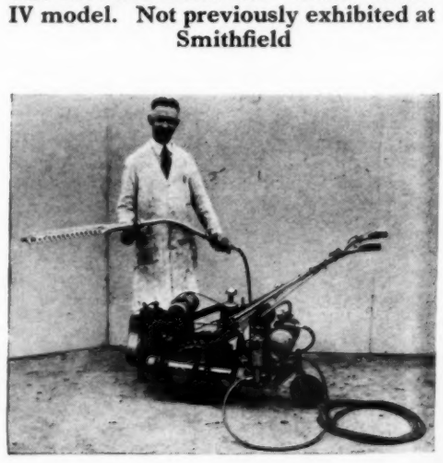
A new machine, known as the ' Hornet,' will be seen on the stand of Messrs. Dashwood Engineering. The machine is a motorised push hoe, powered by a two-stroke Villiers Mark 2 engine. The tool-frame is suitable for mounting all ' Planet ' type tools.

On stands 86 and 103 Messrs. Ransomes, Sims & Jefferies will show a selection of mounted and trailed ploughs, including the five-furrow trailed disc plough, the Husser TD 12. Other mounted implements to be seen will be a low-volume sprayer, potato digger and disc harrow. The M.G. 5 tractor with bar frame, and the 30-in. maize sheller will also be exhibited.

A full display of the complete range of electric fencers and strip grazing equipment made by the Wolseley Sheep Shearing Machine Co. Ltd. will be seen on stand 151. Tent posts and tent insulators which have been introduced in the last 12 months will be included.

Howard Rotavator heavy-duty attachment for the Caterpillar D-7 tractor. Not previously exhibited at Smithfield

The Howard Rotavator ' Gem ' series IV model. Not previously exhibited at Smithfield



Rotary Hoes' ' Shearomatic hedge trimmer—operated off the new compressor attachment to the ' Bantam '

Introducing the New Fordson Major

A MACHINE which is expected to be the focus of much attention at Smithfield is the new Fordson Major tractor, a completely new model designed for row crop work. From the accompanying photographs it can be seen that it bears little resemblance to the old model ; in fact, the only features that have been retained from the latter are the transmission housing, front axle and wheels.

Outstanding new features include the range of speeds (six forward, two reverse), recirculatory ball-type steering, separate petrol starting carburettor on the vaporising oil engine and the simple construction of the hydraulic lift (only three valves).

The new tractor will, of course, be mass-produced, but it has been so designed that the finished engine can come off the line either as a petrol, vaporising oil or diesel type. The cylinder block is cast-iron wet-liner type, enabling the engine to be built as vaporising oil, diesel or petrol type. Inclined overhead valves are used for the petrol and vaporising oil engines and vertical overhead type for the diesel engine. The cylinder block and crankshaft are interchangeable for all three engines. Compression ratios are as follows : petrol, 5.5 to 1 ; vaporising oil, 4.35 to 1 ; diesel, 16 to 1.

The fuel tank is located in front of the instrument panel and has a 15-gal. capacity. On the vaporising oil engine there is a separate petrol carburettor for starting.

Rear view of the new Fordson Major, showing ease of accession to drawbar and three-point linkage

This obviates stalling, because if the engine falters on vaporising oil it can be immediately switched back to petrol to allow the manifold to vaporise the fuel completely.

The gearbox contains six forward and two reverse speeds, giving a very wide range for all types of work. The speeds (m.p.h.) at 1,600 r.p.m. for the eight gears are stated to be as follows : first gear, 2.07 ; second, 2.92 ; third, 3.73 ; fourth, 5.25 ; fifth, 7.32 ; sixth, 13.16 ; low reverse, 2.80 ; and high reverse, 5.03. These speeds can be varied by altering the governor lever ; thus at 1,200 r.p.m. first gear speed is 1.56 m.p.h. Minimum speed in first gear is $\frac{1}{2}$ m.p.h.

The recirculatory-ball system makes steering very light and the tractor has a good turning circle. Extending ends on the front axle provide track adjustment between 49.75 in. and 73.75 in. in 4-in. steps. The tract of the rear axle can be varied between 52 in. and 72 in. in 4-in. steps.

A few points from the engine specification are given below:

Type: four-cylinder in line, overhead valve. Bore: petrol, 3.740 in. (95 mm.); vaporising oil, 3.937 in. (100 mm.); diesel, 3.937 in. (100 mm.). Stroke: 4.528 in. (115 mm.). Cubic capacity: petrol, 199 cu. in. (3,261 c.c.); vaporising oil, 220 cu. in. (3,610 c.c.); diesel, 220 cu. in. (3,610 c.c.). Pistons: low-expansion aluminium alloy with ' barrel ' ground skirts. Connecting rods: forged steel-bronze bushed small ends and replaceable plated indium, steel backed, shell bearings for big ends. Lubricating system: pressure fed by gear type pump; full-flow oil filter fitted direct to cylinder block.

Additional equipment includes a belt pulley and guard, power take-off, hydraulic lift and three-point linkage and an auxiliary hydraulic control unit. The adjustable (vertically and horizontally) drawbar is fitted to the standard model.

The weight of the standard model (with fuel, oil and water) is 4,380 lb. (vaporising oil), 4,360 lb. (petrol) and 4,420 lb. (diesel). Overall length is 130.5 in. and maximum overall width 85 in.

The new tractor will be on show on stand 83.

The new model. Note the compact appearance and cleaner line compared with the previous Fordson tractor

WORLD CROPS

OUR NEXT ISSUE will be Number One of Volume Four. It will contain the first of a series of articles on **how industry aids agricultural research;** each month we shall describe the contributions made by a private firm towards the improvement of world agriculture by research and development in its particular sphere. Besides this there will be an article by S. J. Wright, who is agricultural advisor to the Ford Motor Company, entitled **Some Agricultural Problems of Pakistan.** R. Browning writes on **Reclaiming the New Forest,** and H. Ferguson contributes the first of three articles on **Developments in the Gezira of the Anglo-Egyptian Sudan,** which will be of particularly topical interest. Other articles and regular features will appear as usual.

An Agricultural Pilgrimage in the West of England

IN no part of the world is farming practice changing more rapidly than in Great Britain. During the past decade the new agricultural revolution has accomplished remarkable changes, the most spectacular of which is, of course, the mechanisation of farming. British agriculture can now claim to be the most highly mechanised in the world, but in other directions, too, there have been many changes. Farmers have the reputation of being conservative, but in Great Britain there is a great alertness and willingness to take advantage of recent developments and innovations and to apply in practice new ideas, no matter whether they originate in Britain itself or other countries.

The manner in which this peaceful revolution is accomplishing itself in the western part of England was well brought out in the course of a farming tour organised during the month of September last by the Agriculture and Food Groups of the British Society of Chemical Industry.

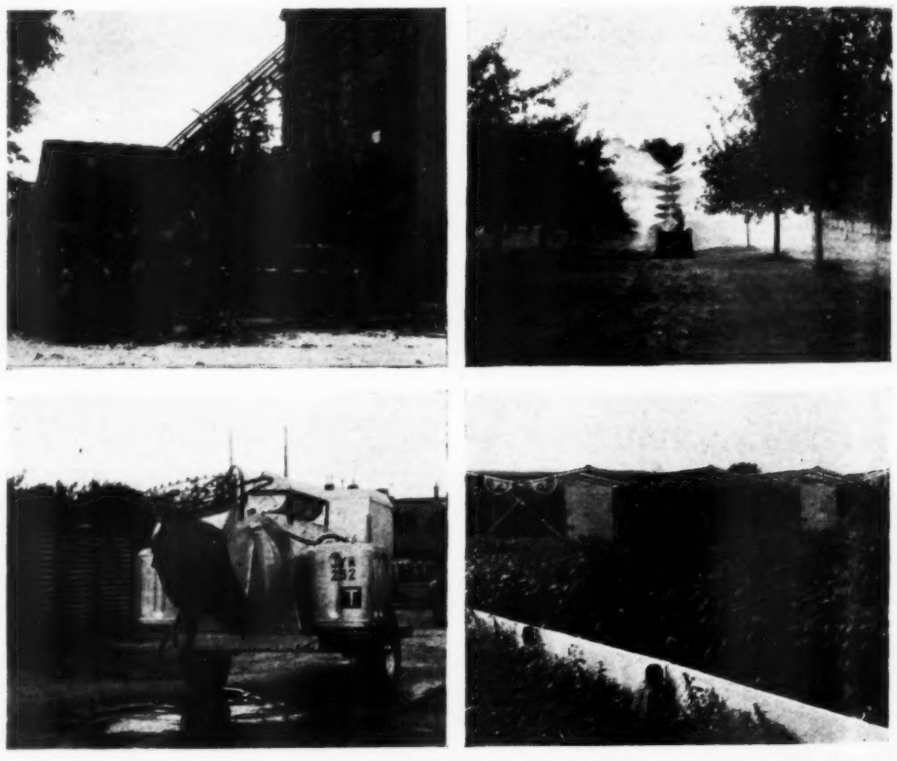
The tour occupied five days and covered the lovely valley of the Wye, the fertile Vale of Evesham and much of the Cotswold country. The area lies in the wetter half of England and agriculture depends mainly on fruit farming, vegetable growing, stock raising and dairying. Arable farming, of course, is practised, but the accent is mainly on rotations comprising barley for stock feed in rotation with leys and fodder crops. Hops are also grown on some scale, while there is considerable development of industries for the canning of fruit and vegetables and the preparation of fruit juices. Cider making is a long-established industry and the cider of Herefordshire, Somersetshire and other localities in this area is world-famous.

Research is catered for by the well-known Long Ashton Research Station, attached to Bristol University, at which all types of research relating to agriculture and horticulture in this part of the world are carried out. Its work, for example, on the effect of trace elements and on plant hormones is widely known and its investigations on cider making have had far-reaching results. The station for research on the preservation of fruits and vegetables at Chipping Camden in Gloucestershire, also attached to Bristol University, has been the foundation on which the British canning industry has arisen. Both these institutions were visited during the tour, as well as a number of farms.

The outstanding impression gained was the manner in which farming practice has been influenced by recent research and by the advisory work of the National Agricultural Advisory Service. The type of agriculture the region lends itself to needs mechanisation less than do the more intensive operations of arable husbandry. Tractors are there in plenty, but for many of the farming operations the horse still retains its place. Mechanisation is finding its application, however, in many other directions such as pruning in the field and also harvesting. An example was seen of a

(*continued on page* 488)

Group taken at Messrs. Bomford's farm at Fladbury during the farm tour; Mr. E. C. Bomford (*centre*) **describes his irrigation system.** (*Left to right*) **Sir Harold Tempany, Prof. T. Wallace and Mr. A. C. Bates Smith**



(*Top left*) **Hop vines entering a mechanical viner by conveyor at Fladbury.** (*Top right*) **Spraying demonstration at Long Ashton Research Station.** (*Bottom left*) **Prototype spraying machine at Long Ashton.** (*Bottom right*) **The greenhouse in the background is movable and in due course it will be moved along rails to cover the chrysanthemums in the foreground**

Collective Farming in Yugoslavia

DR. C. de FELLNER

ONE of the most important problems of today's agriculture is whether it can be based entirely on smallholdings or whether these should be replaced sooner or later by some other system. Though, from the human point of view, the individual system of smallholdings seems to be the most satisfactory, it has its technical limitations. In many instances it cannot produce enough to feed the population of a country, its returns to the farmer himself are unsatisfactory and insufficient to keep himself, his family and his farm as a going concern. Could collective farming replace the smallholdings and can this be reconciled with human freedom? Could the farmer be induced to accept this system of his own free will?

This is the problem of the day in Yugoslavia. Though five years have elapsed since the introduction of the collective system, it has not gone far beyond the experimental stage. It is characteristic of this courageous and outspoken nation that instead of following the example of some other countries where technical information is constantly distorted for the sake of political propaganda, their experiment is carried out quite openly before the eyes of the whole world and, therefore, offers an invaluable opportunity to observe in every stage of development.

Collective farming has been widely discussed as a possible solution to present-day difficulties and, accordingly, this description of the system as it is carried out in Yugoslavia is of topical interest. The author has recently returned from an extensive tour of that country.

The general background

The Federal Republic of Yugoslavia is composed of the Republics of Serbia, Croatia, Slovenia, Montenegro, Bosnia-Herzogovina and Macedonia. It is the largest country in the Balkans, covering an area of about 100,000 square miles, with a population of 16 millions. It is mostly mountainous in the south, with great plains of extremely fertile soil in the north, especially in the autonomous province of Voivodina, integrated now into the Republic of Serbia. The mountains are covered by dense forests, except those sloping towards the sea, the so-called Karst, which are barren areas of rocks interspersed by small patches of mostly Redzina soils, all very poor pastures.

The Federal Republic of Yugoslavia, covering an area of about 100,000 square miles

Agriculture is diversified. The most important cereal is maize, grown all over the country. Wheat gives excellent returns in the northern plains and in some parts of Croatia. Oats and barley are grown almost everywhere, rye in Croatia and Slovenia, rice in Voivodina and Macedonia. Among industrial plants the most important are sugar beet, cotton and tobacco. High quality hemp is grown in Voivodina, and flax is also grown there on a considerable acreage, as well as in Croatia. Beans are grown on a large scale, as well as oil plants, mostly sunflower, and some rape, sesame and linseed.

There is some very rich pasture land in Croatia, Slovenia and Serbia. The foremost leguminous forage crops are lucerne and red clover. Wine and fruit, especially the celebrated plums of Bosnia should be mentioned.

Livestock was badly reduced through the ravages of war but replacement is remarkable. Generally speaking Yugoslavia has the natural pre-eminence of a rich agricultural country.

The introduction

Collective farming was introduced in Yugoslavia as much for practical as for ideological reasons. Post-war shortage of manpower was the first among them. A totally destroyed country had to be rebuilt after terrible losses of population. Serious economic reasons favoured the industrialisation of the country. At the same time a large military and police force had to be maintained which sapped the young manpower. Quite logically, the Government tried to tap the only valuable labour reservoir, *i.e.* agriculture. Through the collective system a large part of the agricultural population would become redundant and could be switched over therefore to industry. Undoubtedly this is what happened, but to the detriment of agricultural production.

The condition of the peasants in pre-war Yugoslavia was different from that prevailing in the neighbouring countries. A more or less successful land reform had converted it into a country of smallholdings and the peasants, chiefly in the rich agricultural parts of the country, were not on the whole discontented.

For the reasons mentioned above there was no need after the war for land reform, as carried out in most of the Communist dominated countries, which is the first step towards collective farming, as it disrupts

the previous structure of agriculture and creates an element of landless agricultural workers. These are the fermenting agents for building up collectives ; as a rule they have neither funds, nor livestock nor implements to make a profitable job of their newly-acquired holdings. This group was not dominant in Yugoslavia, but nevertheless existed.

There was land to be distributed after the war owing to the expulsion from the country of smallholders of German origin for their unpatriotic behaviour during the war ; a large number of farmers perished in the war and some of the land was confiscated for one reason or the other. The new owners proved to be the pioneers of the collective movement in Yugoslavia.

It is no use denying that a large number of the peasants were not enthusiastic about collectivisation. This is due not only to the overwhelming individualism of the Yugoslav peasant. In terms of years they are not far from serfdom and thus the compensation which the Government could offer them—lighter taxation, allocation of machines, credits, etc.—were far from being enough to counterbalance their wish to be their own masters. Nevertheless, the balance would probably have turned if full-scale mechanisation could have been introduced.

This process would have had excellent results, especially in the large plains of the Voivodina and in the not-too-mountainous parts of Serbia, Croatia, Slovenia and Macedonia. It did not succeed because Yugoslavia's planners wished first to build up its heavy industry and, although the country has rich mineral, agricultural, forestry and energy resources, it has neither the economic power nor the technical ability to carry out three large-scale programmes simultaneously, *i.e.* reconstruct the country, build up its heavy industry and mechanise its agriculture. So the latter had to suffer. This was admitted frankly by Marshal Tito not long ago and had its natural repercussions. Production deteriorated, though this can be partly ascribed also to some years of exceptionally bad weather, and the initiative and impetus of an easier and better mechanical agricultural method failed to impress the peasant, for whom, therefore, collective farming could not have the desired appeal.

Progress in collectivisation

However, the Government had to go ahead with the collectivisation scheme and, as a result, the number of cooperatives and their members rose steeply from 1946 onwards. The table below shows the progress made in this connection during the past five years.

Very wisely the so-called 'Model Regulations' issued in 1946 indicated in principle that not only did the formation of the cooperatives depend upon the free will of the farmers interested in the scheme but that there need not be strict uniformity in the type of the cooperative, which could be adapted to suit the requirements of its members.

	1946	1947	1948	1949	30 6 1950
Number of peasant work cooperatives	454	779	1,318	6,626	6,971
Number of families ..	25,062	40,590	60,156	340,739	415,398
Land in hectares	121,518	210,986	323,984	1,839,978	2,157,786

Tractor-drawn binders in line ahead on a collective farm

Types of cooperatives

With some minor exceptions, the four main types of cooperatives are as follows :

(1) Fields are rented for up to 30% of the income to the cooperative. One hectare remains under the private management of each farmer. He can keep one cow, one or two pigs and five to ten sheep and poultry. Fodder for these animals is provided by the cooperative. The farmer has to work in the cooperative.

(2) All fields are taken over by the cooperative. As indemnity the farmer receives 6% of the value of his property, a special percentage of the income of his fields and a further sum for his work.

(3) All land of the members is taken over by the cooperative. Work and income are divided between members, but the fields still remain individual property.

(4) As above but without individual ownership of the fields.

All cooperative members of types 2, 3 and 4 retain a small plot for a kitchen garden, some poultry and one or two pigs.

Some comprehensive figures for the Republic of Serbia, which includes the most fertile agricultural part of Yugoslavia, show the percentual distribution of the four types of cooperative there as :

Type 1	219
Type 2	279
Type 3	827
Type 4	258

There is no evidence that this percentage should show any marked preference of the farmer for one or the other type.

General statistics for the whole country show that 421,000 individual smallholdings of 0.1 to 10 hectares have been replaced by nearly 7,000 working cooperatives, producing now on an acreage of 50 to 6,800 hectares.

In the grain-producing plains of Voivodina the average amount of land per cooperative is 960 hectares. The largest cooperative farm has an acreage of 6,800 hectares.

All members have to sign a three-years' contract with the cooperative and theoretically any member can be released, if he so wishes, after this period.

Working members of the cooperative are organised in so-called brigades. Opinions differ considerably as to whether these large groups should contain 15 or 30 members,

(*Left*) **Discing stubble on a peasant-owned farm in Yugoslavia** (*Right*) **Peasants working in the fields. Much hand labour is still carried out**

or anything in between. The brigades are divided into small groups of generally five to seven members. It is still not decided whether there should be allocated to each brigade a separate strip of land where all field work is done by the same group, or whether it is better to introduce a system where the brigade works all over the co-operative fields just as it is done on the State farms, or the system which was used previously on the big farms in private hands. In the first case the responsibility of each member with regard to the strip of land under his own cultivation is somewhat more pronounced, whereas in the second case machines and manpower can be more efficiently utilised.

A further point of controversy is whether the leader of the group should work himself or only direct operations. Complaints were made that in times of great labour shortage each working hand was needed and that it might do more harm than good if the leader did not take a hand himself. On the other hand, the direction and organisation of the work suffered if the leader could not spare enough time for his real job because he had to work himself.

Accountancy and profit distribution

The system of accountancy, distribution of profits, etc., is rather intricate. There are some theoretical norms which give a general indication regarding results that should be achieved ; for instance, wheat or barley would need 12 working days per year per hectare, maize or sugar beet 22 working days. Practical results are totally different as the manpower utilisation varies in different parts of the country. For instance, the working days per year and member for the year 1949 were, for the cooperatives in Voivodina 105 days, in Serbia, 100 days and in the region of Kosovo 95 days—not too impressive figures. If their own personal work in their household and personal strips of land is deducted, only two-thirds of the manpower fund is utilised for the cooperatives work in Serbia and Kosovo, whilst three-quarters is the proportion in Voivodina. The figures for woman labour are still worse, as they show that they work only for 66 days per year in Serbia—this means about 44% of the male member's working time.

It is remarkable that besides the manpower surplus on the farms which is naturally seasonal, being 50% in the first quarter, 20% in the second, 14% in the third and 33% in the fourth, there is also a general surplus in manpower which has been calculated at 16% for Serbia, 21% for Kosovo, but only 2.3% for Voivodina, which shows how much better the organisation of labour is in some parts of the country than in others. It is self-explanatory, but still rather interesting, that the cooperatives have found the same trend regarding labour utilisation as is well known under free enterprise, i.e., that in cooperatives of under 100 hectares arable land, the number of working days per hectare is 100% higher, and in cooperatives of 100-300 hectares, 53% higher than in the cooperatives of 2,000 hectares.

Not only the system of distribution of the income of the cooperatives, but the payment in kind of members, is still at the experimental stage. The system of distribution of income in grain or other commodities is rather unsatisfactory in so far as the income is distributed, for instance, as is generally the practice, each quarter year. There is not so much work in the first and second quarters and it seems that distribution would be on a fairer basis if it were made according to the working days of each preceding month. The main difficulty is finding the right method to pay for incentive. The whole book-keeping and accountancy system has to be reorganised and a new, less intricate, system has to be found.

Marketing

It will be most instructive to see how the collectives will cope with the new system of free marketing which has been gradually introduced for practically all agricultural products. The important problem of competition will be a new experience and it may be that the operations on a free market will give new impetus to the system which has been tested up to now only in a regulated market with fixed quotas and prices for deliveries.

The result of the recent abolition of all delivery quotas on this year's excellent crop brought, for instance, a totally novel marketing situation. The farmer, partly due to lack of machines, partly hampered by rain during harvest time, and under no compulsion from any authority to deliver to date, is showing a not unusual reluctance in bringing his crops to market. This means that the whole marketing system is slowed down and, for example, pulses which ought to be already on the market, will be offered only considerably later

than usual. The cooperative buying organisations are still somewhat in the dark, not only regarding quantities available but concerning prices as well. This is naturally most disturbing from the export point of view, where selling contracts are being postponed as the exporters are not yet sure of the availability of the commodities. Fortunately, this deadlock is only temporary as most of the grain crop—except for maize, where the crop is coming in only in September or October—will be for home consumption only and not for export. On the other hand an abundant crop will automatically induce the producer not to hold back artificially for a long time goods from the market. The natural balance of supply and demand will soon clarify the situation.

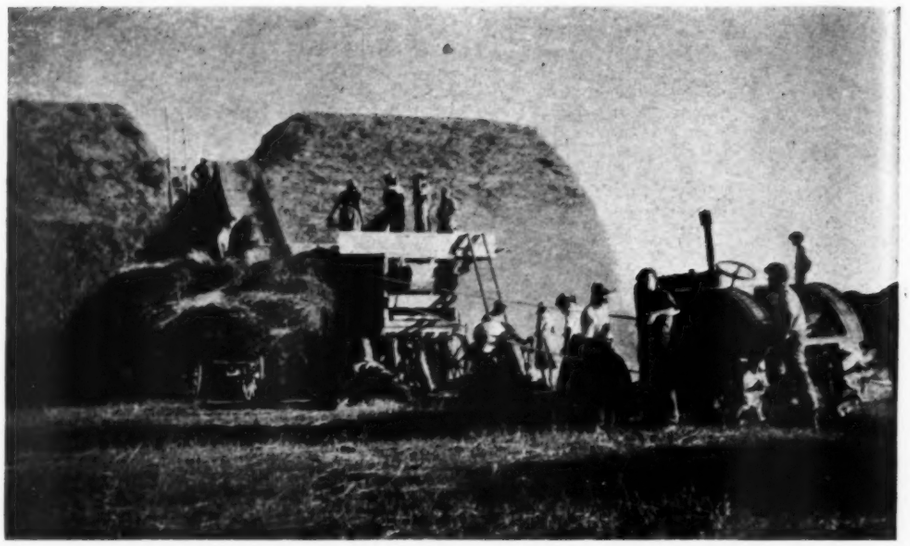
Free competitive marketing means also a very interesting test case for the leaders of the collectives and here some anxiety must be expressed, as until now deficiencies of technical knowledge have been observed which hamper the development of the movement. As the commercial aptitude and especially the practical knowledge of the young generation has had very little opportunity to develop, some further disappointments can be expected.

Conclusion

In the above circumstances it is difficult to form an opinion whether the collective farming system introduced in Yugoslavia will be successful. The picture is the more blurred because consecutive droughts since 1948 resulted in very unsatisfactory harvests, followed this year by a bumper crop. On the other hand, the prerequisite of collective agriculture, full-scale mechanisation, has not been fulfilled. It would, therefore, be premature to pass any judgment on this highly interesting experiment.

Improvements in DDT Spraying

In last month's article with the above title, by G. A. Emery (pp. 433-435), we much regret that two errors appeared in the captions. On page 433 the *left hand* photo-micrograph shows good quality dispersible powder and the *right hand* photograph shows crystalline paste material ; not, as stated, the other way round. On page 435, under the dispersion stability curves A is the paste suspension and B, C and D are three different grades of wettable powder. D is *not* the paste suspension, as stated.



Threshing the harvest from a collective farm. Note the size of the straw stack

An Agricultural Pilgrimage

(*concluded from page* 484)

mechanical hop-picker of the type developed in America. A number of farms are equipped with plant for the spray irrigation of orchards and field crops.

In the field new techniques for crop protection are widely used ; spraying with plant hormones for the prevention of premature fruit drop has been extensively employed during the past rather unfavourable season, while the use of modern spraying methods and the newer preparations for the control of pests and diseases is widespread. Knowledge of the effects of plant deficiencies brought out by recent research is being applied in the fields, notably in regard to magnesium deficiency.

Modern methods of grading and packing fruit using mechanical equipment are employed on a number of fruit farms, while increasing use is being made of cold-storage methods of holding fruit to enable advantage to be taken of favourable market conditions.

Glasshouse horticulture has developed considerably in some areas and an example was seen of the technique developed by the Dutch of using movable glasshouses of considerable size for the growing of the ordinary glasshouse rotations, where the entire glasshouse is moved from one part of a field to another to cover the various stages. Grass drying has developed extensively and examples were seen of the use both of centralised driers and transportable machines for use in the field. There has also been widespread extension of ensiling, pit silos being mainly favoured, although other types are also used.

The photographs on page 484 illustrate some of the features of the tour.

The Dairy Show

The 65th Annual Dairy Show, organised by the British Dairy Farmers' Association, was held at Olympia, London, from October 23-26. 324 cows representing 11 different breeds were on show. The greatest number of any one breed were the British Friesians, numbering 67, followed by Ayreshires, Jerseys, Guernseys, Dairy Shorthorns, Red Polls, Kerries, South Devons, Dexters, Lincoln Reds and Welsh Blacks in that order.

For the fourth successive year British Friesians won the Bledisloe Challenge Trophy for the best exhibit of good all-round dairy cows ; Ayreshires again took second place. The Supreme Individual Championship was also won by a British Friesian.

A large proportion of the trade stands, numbering just under 500, showed dairying equipment such as milking machines, bottling and capping machines, ice cream conservators, etc. Among the firms of a more agricultural nature Messrs. Wolseley Sheep Shearing Machine Co. Ltd., showed some new electric fencing equipment for which they were awarded a Silver Medal. Messrs. Mitchell, Colman Ltd., showed their range of grain-handling equipment and their stand was dominated by a Spirolift pick-up grain conveyor which works on an archimedian screw principle.

The Government of Canada had an exhibition of the Dominion's produce—bacon, hams, poultry, cheese, eggs and apples—which were very attractively displayed. Australian and New Zealand butters and cheeses were seen in the respective sections for these products.

Experimental Agriculture

Part II

Dr. E. M. CROWTHER

Concluding the shortened version of Dr. Crowther's presidential address to the Agriculture Section of the British Association at this year's meeting, Part II covers fertilisers and manures, the changing systems of land use and experimental techniques.

EVERY farmer who uses fertilisers must make up his mind how to allot them between his various fields. The rules for rationing nutrient elements to soils and crops are much less understood. When a fertiliser policy had to be worked out on a national scale during the war, E. M. Crowther and F. Yates showed how the results of past experiments in the United Kingdom and Northern Europe could provide an efficient means for adjusting fertiliser practice to varying supplies of materials and priorities for crops.

The principles were embodied in the fertiliser rationing scheme for individual farms. Similar methods may be applied far more generally. The first step would be to obtain the average responses of each crop to standard amounts of nutrient elements, and then to evaluate the most profitable rates. The next step is to make adjustments for local soils and conditions. Thus, less nitrogen and more phosphorus would be required in wetter regions, and less phosphorus and potassium on the dunged fields. Recommendations on these lines might become part of the advisory services of official bodies or farmers' organisations, when the necessary field experiments have been made.

Fertiliser practices

How much remains to be done in relating fertiliser practice more closely to soil conditions may be seen by noting some of the variations between neighbouring countries. In both the United Kingdom and the United States, where fertiliser consumption has almost trebled in the last ten years, the elements N, P and K are used in roughly similar proportions, about 200,000 tons of each in the United Kingdom and 1,000,000 tons of each in the United States. In the Netherlands, which uses fertilisers about twice as heavily as the United Kingdom, N : P : K ration is about 1.0 : 0.3 : 0.8, and in Germany it is about 1.0 : 0.5 : 1.5. At first sight these variations might be taken to indicate differences in the soils and agricultural conditions, but field experiments in several western European countries show very similar average responses to unit amounts of N, P and K in fertilisers.

Similar differences are found in the kinds of fertiliser employed. Thus, nitrogen is used mainly as ammonium sulphate in the United Kingdom as ammonium nitrate in the Netherlands and as calcium nitrate in Denmark. In the United Kingdom and the United States most fertilisers are used in mixtures, but little or no mixed fertiliser is sold in the Netherlands or Denmark. In the United Kingdom mixed fertilisers are mainly in granular form and almost all of the phosphorus is in water-soluble compounds. In the United States most of the mixed fertilisers are sold as powders with less than half of their phosphorus in water-soluble forms. Anhydrous ammonia and ammonium nitrate are produced more cheaply than ammonium sulphate in the United States and they can be included in mixed fertilisers only by reducing the solubility of the phosphates present.

There are many alternative kinds of phosphorus fertilisers. The current sulphur shortage gives particular interest to those made without sulphuric acid, *e.g.* concentrated fertilisers made from phosphate rock, nitric acid and ammonia. On very acid soils finely ground untreated rock phosphate may be economical, especially if used to build up reserves by heavy occasional dressings with small amounts of a soluble phosphorus fertiliser drilled with the seeds of most crops as a 'starter.'

Much careful work will be needed before the value of some of the newer forms can be properly assessed. In the past many fertilisers of low efficiency were overrated because they were tested in the field only at heavy rates. All comparative trials on kinds of fertiliser or liming material should be made at relatively low rates of application and at least one of the materials should be used at two different rates to indicate the sensitivity of the experiment.

Very few experiments have been made to measure the rate at which fertiliser effects fall off over years. It is therefore difficult to estimate compensation for unexhausted manurial values or to make practical use of laboratory investigations on fertiliser residues in the soil. Fertilisers are commonly applied close to the seeds, but the residues are dispersed throughout the soil by ploughing. As residual effects are generally small, farmers are advised to give frequent light dressings and to regard the soil as a poor storehouse for nutrients. Yet landowners often insist that heavy manuring has lasting benefits. This has recently been illustrated by a continuous barley experiment at Rothamsted in which striking gains are still shown from farmyard manure or superphosphate given last century with none since. The total applications had been so heavy that even a small percentage residual effect is enough to ensure good barley crops 50 years later.

Fertiliser application

Great progress has been made in recent years in applying fertilisers in special positions near the seeds. Combined fertiliser-seed drills for cereals have come into general use in Britain. Although some promising results have been obtained for other crops, much more research will be required before we can expect to obtain benefits from band placement approaching those for cotton and maize in the United States. We also need trials to know whether it is economic to spread superphosphate on the hills from aeroplanes as is being done successfully in New Zealand.

In tropical and other areas where transport costs are high, special attention should be given to obtaining large immediate returns from small quantities of concentrated materials. Most promising results have been obtained in Northern Nigeria by dropping a few granules of concentrated superphosphate into the planting holes for groundnuts. In East Africa the results of fertiliser experiments are being waited before the authorities decide whether to install a factory for treating local phosphate rock or to fix nitrogen by hydro-electric power. As a long-term policy in remote countries the possibility of shipping out highly concentrated materials, such as red phosphorus, for processing locally should be examined.

The farming of many parts of Britain has been transformed in the last dozen years by establishing leys with new strains of herbage plants and better manuring. One of the main uses of fertiliser is to make it possible to introduce new crops of better nutritive value. Fertilisers have relatively small effects of the chemical composition of plants when the comparisons are made on a weight basis at similar stages of development. Manuring land for suitably managed leys increases the total amount of herbage and its content of protein, calcium and phosphorus by increasing the proportion of clovers and keeping the grasses in the leafy stage. In Africa improving soil fertility will improve human nutrition, not by changing the composition and nutritive value of grains but by providing more food in greater variety and more cash crops.

Soil organic matter

Many discussions of soil fertility stress the contribution made by plant roots and crop residues and the role of the grazing animal. Under many conditions the benefits from resting land under leys can be obtained economically only by using livestock to consume the herbage, but it is difficult to analyse two different systems of farming without many arbitrary assumptions on costings.

In the latter half of the 19th century most of the additional plant nutrients brought on to British farms were in imported feeding stuffs fed to stock in covered yards. To save these and to convey them to the arable land, it was essential to tread straw into manure. The rules of good husbandry of the period penalised the sale of straw off the farm. In some quarters the rough rule that one ton of straw gives four tons of manure is still treated as a statement of manurial equivalents, ignoring the fact that most of the nutrients come from the feeding stuffs and not from the litter. The few experiments made with varying quantities of straw for fixed amounts of feeding stuffs have generally failed to show much difference in the resulting crops; much of the straw is oxidised away before it reaches the land. Where straw is used directly it is often necessary to supply additional nitrogen to compensate for that immobilised as the straw rots. The few experiments have shown, at least on heavy soils, that yields of root crops may be improved by ploughing in straw perhaps through improved soil structure.

Sometimes the main contribution of livestock to soil fertility is to collect nutrient elements from catch crops or rough grazings. During war-time discussions I suggested that benefits commonly ascribed to the 'Golden Hoof' of the sheep might more properly be ascribed to the potassium collected and concentrated in the surface soil in the manure of the folded sheep. Experiments showed how good barley crops could be raised by suitably placing fertilisers with high potassium contents.

In many systems of farming leguminous crops provide the main source of additional nitrogen, and in many parts of the world one of the urgent problems is to find methods for establishing suitable legumes, on arable land and in pastures. On the other hand, experiments have revealed cases in which it may be more profitable to rely on nitrogen fertilisers. The Woburn experiments on vetches and mustard before winter wheat showed that the nitrogen fixed by the legume was lost before the wheat could use it.

Manurial experiments on pastures have often given disappointing results. Plots improved by manuring have given poorer live-weight increases because with fixed numbers of animals they were undergrazed. Attempts are now being made to work out techniques for small plots by sample-cuts or by weighing faeces. Until better techniques are developed we shall lack quantitative data on the management of pastures, the residual benefits from leys and the relative merits of 'alternate husbandry' and 'two-compartment farming.' In an experiment started at Woburn in 1938 the yields of test crops of potatoes and barley after three years of grazed ley or repeatedly cut lucerne are better than those after three years of arable crops, including seeds hay. In a more ambitious pair of experiments at Rothamsted an attempt is being made to compare the effects of grazed leys, repeatedly cut grass leys, repeatedly cut lucerne and a rotation of arable crops on the yields of subsequent arable crops and, to measure the productivity under grazing conditions of three-year leys and very long leys.

It has often been assumed that there is some critical length of ley for improving soil structure, but, for the steppes of the Soviet Union, W. R. Williams has made the suggestion that there should be two patterns of alternate husbandry on the same farm. On the ridges and gently sloping land a short rest under ley should be regarded as a regrettable necessity. Low-lying pastures should be broken up occasionally for a short spell of leafy fodder or industrial crops.

The classification of crops into 'soil improving' and 'soil exhausting' is a somewhat arbitrary expression. Row crops and leys remove more nutrients than cereals, which are often regarded as 'exhausting.' Where erosion is serious, all widely spaced row crops are dangerous until they cover the soil. If erosion risks can be reduced by suitable cultivations, the gains from leguminous crops in dry areas may be offset by the large amounts of water they transpire, and in some parts of the prairies it may be better to run the soil at a lower level of organic matter and supply nitrogen in fertilisers.

Changing systems of land use

During the last decade or so there have been many examples in the reconditioning of worn-out and neglected land, sometimes by new methods of management and schemes of drainage or irrigation. In several parts of the world important decisions must be taken about the most profitable direction in which to invest new capital for agricultural development. Should it be in large new schemes of irrigation or bush-clearing in under-populated regions, or would it be better to improve land in settled and often over-crowded areas? An example on a vast scale is afforded in the United States by comparing the likely returns from the Columbia Basin Project with those from liming and manuring the impoverished soils of the south-eastern States. Tennessee has shown how the countryside can be restored by starting with phosphorus fertilisers and pastures. North Carolina has recently given a demonstration of what can be done in a short time by a research programme based largely on factorial experiments on maize.

Such changes cannot properly be analysed in terms of the simple law of diminishing returns, which applies only to variations in one factor at a time. They amount rather to what American economists term 'production innovations' or 'complex resource combination changes.'

Field and laboratory research

When faced with problems requiring long and expensive experiments in the field, many are inclined to look first to the chemist. In recent years this tendency has been accentuated by progress in pure sciences with potential applications to agriculture and by the need for splitting agricultural research into units of two or four years for university theses.

Many laboratory techniques are too elaborate to be applied to the large numbers of samples needed in modern field experiments and soil surveys. Sometimes the difficulty arises in the opposite direction. Physical and biochemical investigations on soil structure are held up through lack of soil samples in which contrasted structures

have been produced under experimental control in rotation experiments. So far the field experiments required have proved too difficult.

It is essential that field experimental work should not be wasted on matters of purely local and temporary concern, but should be planned to make full use of and to provide raw material for investigations in other branches of agricultural science.

The problem of balancing the approach may be simplified, if it is realised that agricultural science does not seek to establish general principles from which agricultural practices may be deduced, but may be regarded as a search for patterns to fit suitable landscapes. Its starting point is current practice in the region concerned. The features of many environments and the effects of agricultural operations can be classified sufficiently well for forecasting the effects of moderate changes, but it is unwise to make drastic innovations without pilot schemes and detailed experiments.

I cannot summarise my argument more concisely than by quoting the final paragraph from the introduction to Johnston's *Experimental Agriculture*, published in Edinburgh just over a century ago.

' It is only by means of conjoined experiments in the field, the feeding-house and the laboratory—all made with equal care, conscientiousness and precision — that scientific agriculture can hereafter be with certainty advanced. If we have been long in getting upon the right road, we ought to advance the more heartily now we have found it.'

First Agricultural Air Service Formed in U.K.

A company has been formed in Great Britain—the first of its kind—to further the use of aircraft for agricultural purposes. The firm, Dragon Agricultural Air Services, intend to seek work in connection with the development of hill, moor and marginal land, of which there are 4,000,000 acres scheduled for development.

It has been decided to use a medium-powered aircraft, the Prestwick ' Pioneer,' which can take off and land in comparatively small fields and is capable of flying at exceptionally low speeds. Assuming an annual flying time of 1,500 hours, the capacity for distributing fertiliser is 4,500 tons. At a distribution rate of 1 cwt./acre, area capacity would be 90,000 acres a year. The quoted charge for distributing fertilisers on hill land is £5 per ton, irrespective of density of spread.

NEW BOOKS

Trace Elements

in Plant Physiology. Pp. 144. Illustrated. Waltham, Mass. The Chronica Botanica Co., William Dawson & Sons, Ltd., London, W.C.2, 1950, $4.50.

This is the third in the series of volumes issued under the general title of ' Lotsya ' sponsored by the International Union of Biological Science. It comprises the papers read at an international symposium organised by the International Union of Biological Sciences with the support of UNESCO at Rothamsted Experimental Station, England, in November 1947.

At the present time, considering the rapid way in which knowledge of this very important matter is advancing, the original papers are to some extent out of date. This is, however, corrected to an extent in a preface contributed by Professor T. Wallace of Long Ashton Research Station, and by short addenda to some of the papers.

As Professor Wallace points out, the symposium was important because it brought together after the isolation of the war a number of workers from countries in Western Europe who, during the war, had been engaged in important investigations in this field, in the course of which a number of trace element deficiencies had been shown to have considerable economic importance.

The conference was opened by the late Professor Nemec, formerly Professor of Plant Physiology at the University of Prague, who briefly traced the evolution of knowledge on the subject. The papers presented deal with the effects of deficiencies and excesses of trace elements in various countries of Europe and the U.S.A., including much information on technical methods of determining them. They are more particularly interesting to the specialist, although some of them are valuable to the general reader.

Of special interest are Dr. Mulder's paper on the importance of copper and molybdenum, Dr. Seekle's paper on the action and occurrence of trace elements in pastures and animals and Professor Wallace's paper on visual diagnosis in trace element problems.

The book is admirably printed and well illustrated by 27 figures in the text and 10 plates.

It can be cordially recommended to the student and the research worker as a source of information on a variety of aspects of this increasingly important subject.

Scientific Horticulture

Hon. Editor, R. T. Pearl, M.Sc., A.R.C.S., D.I.C. Pp. 240, illustrated. Horticultural Education Association, 16 Orange Street, Canterbury, Kent, 1951. 10s. 6d.

This is really the annual journal of the Horticultural Educational Association, whose headquarters are at Long Ashton Research Station, Bristol. It contains some 23 authoritative articles on contemporary horticultural work in the U.K. and also overseas.

The mixture is varied, ranging from a detailed article on pot-plant growing to a general description of the horticultural work of the National Institute of Agricultural Engineering and one on the importance of meteorology to horticulture. Most of the articles are original contributions ; some are reprints of papers read at various conferences, etc.

There is, needless to say, much valuable material for the horticulturist in these articles and those who are not members of the H.E.A. would do well to get hold of a copy of this (Volume 10) journal.

Soil Survey Manual

By the Soil Survey Staff, Bureau of Plant Industry, Soils and Agricultural Engineering, U.S. Department of Agriculture. Pp. 503, illustrated. Government Printing Office, Washington, D.C., 1951. $3.00.

This is a revised and enlarged edition of the U.S.D.A. Soil Survey Manual issued in 1937. As such it has been enlarged and brought up to date, the new terminology (in part) replaces the old and its contents include most of the subjects that are encountered while carrying out soil surveys.

The book is written by Americans for American soil surveyors in particular and gives an insight into the techniques employed in the U.S.A. For instance, practically all soil mapping is now done from aerial photographs, and the detailed thoroughness that goes into a survey is immense. One feels, after reading this book, that one could almost carry out a soil survey without further instruction, so detailed is it.

Much of the information in this manual is, of course, not new, but even as a reference book it will be a valuable addition to the soil scientist. Soil surveyors throughout the world will find plenty of use and of interest here, even though their methods may not be quite the same as those employed in the U.S.A.

WORLD CROP REPORTS

WORLD

1951 barley and oats production. World production of barley and oats in 1951 is tentatively forecast at about 6,905 million bushels, according to information available to the U.S. Department of Agriculture. Of this figure, the barley crop should provide 2,600 million bushels and oats 4,305 million, which would compare with crops of 2,435 million bushels and 4,210 million respectively in 1950. The outlook, therefore, is for an above-previous-average barley crop (2,365 million bushels in 1935-39) and a smaller oats crop (4,365 million in the five pre-war years).

In North America the barley yield should be 520 million bushels against 480 million last year, while European harvests should give 740 million against 695 million. The Asian crop is put at 795 million bushels (735 million), the African crop at 123 million and Oceania 26.2 million against 28.3 million.

North American oats output is put at 1,884 million bushels (1,889 million), European at 1,390 million against 1,360 million, Asian at 101 million against 96 million, African at 25 million against 24 million, South American at 53 million against 57 million and Oceanian at 36 million against 34.8 million.

AUSTRALIA

Queensland—Q.F.C. sorghum crop. The Queensland-British Food Corporation has announced a sorghum harvest of some 430,000 bushels, or about 11,620 tons. The Corporation will provide 12½% of this year's harvest for the local market.

Experimental cane grown in Kimberley.—Sugar cane is now being grown experimentally in the Kimberley district of Western Australia and samples are said to be equal to anything grown in Queensland. At the Ivanhoe experimental station today tropical plants being grown include sorghum, peanuts and various pastures.

Encouraging cotton increase.—Queensland cotton growers have promised to grow more than 7,000 acres next season if the Cotton Marketing Board can guarantee mechanical harvesting for that acreage. The Board has started a campaign to induce dairymen to grow small areas, as half of the Queensland dairymen are in cotton areas. General manager of the board, Mr. B. C. Johnson, says: 'If each of those 5,000 dairymen would put five acres under cotton it would mean the production of 2,000 tons of 40% protein cotton seed meal, one of the richest protein meals available.'

U.S.A.

Another good grain year. Although the official report on U.S. grain production shows a modest scaling down and all crops—except spring wheat—will not reach last year's production, generally U.S. farmers had another good year.

Total wheat production now stands at 993.6 million bushels (650.7 winter and 342.9 spring), compared with last year, when all wheat totalled 1,026.8 million (750.7 winter and 276.1 million spring). This is the first time in eight years that the U.S. has failed to harvest a 1,000-million wheat crop.

Maize production is now put at 3,105 million, against 3,130.8 million a month ago and 3,131 million a year ago, and oats 1,378 and 1,465.1 million respectively. In oilseeds, the linseed crop is put at 32.3 million, compared with 35 million forecast in September and 39.3 million harvested last year, and soya beans 271.2 million, against 273.4 million and 287 million respectively.

TURKEY

Good wheat crop. Turkey has had a bumper wheat harvest this season, the exportable surplus being estimated at about 100,000 tons, according to a dispatch from Ankara Radio received in London. Syria and the Lebanon, which formerly exported wheat to Turkey, have already asked if they can import wheat from her, it was stated. Syria wanted 50,000 tons and the Lebanon 25,000 tons.

ARGENTINA

Crop survey. The official Argentine crop survey says that weather conditions have been generally unfavourable with light rains, sharp temperature variations and high winds delaying the development of fine crops, especially in Cordoba and Sante Fe. These factors, coupled with invasions by green bugs and locusts in these provinces, have resulted in an almost complete loss of the wheat crop there. The condition of wheat in the remainder of the country was described as normal.

SPAIN

Wheat requirements met. Latest estimates put this year's Spanish wheat yield at 4,200,000 tons which, under rationing, should enable domestic requirements to be met without imports. Last year's crop was 3,200,000 tons.

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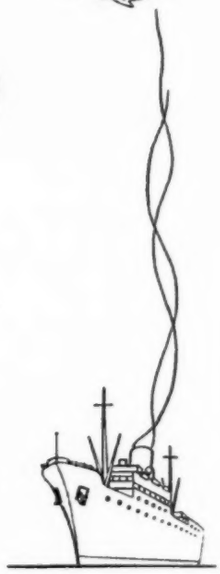

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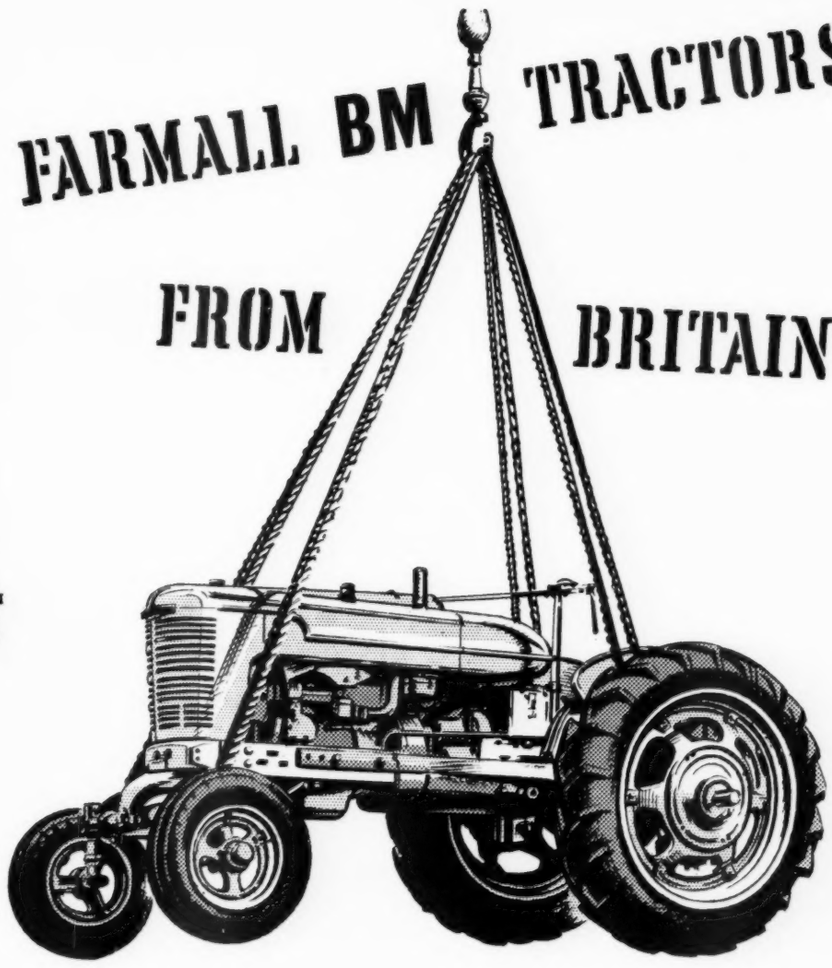

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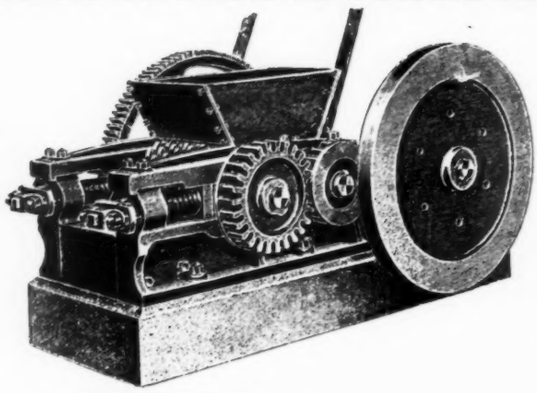

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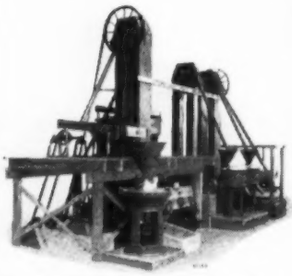

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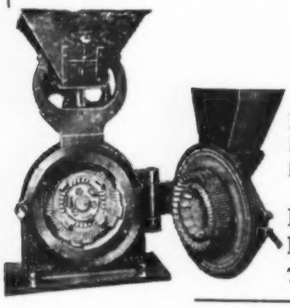

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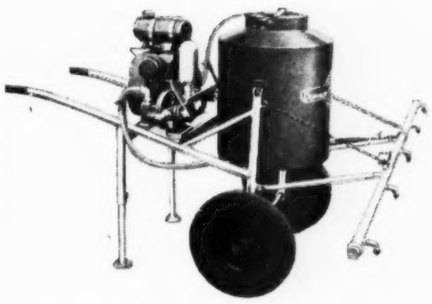

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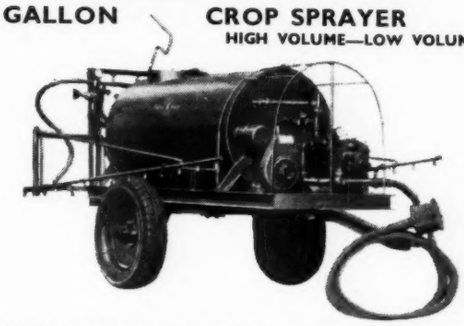

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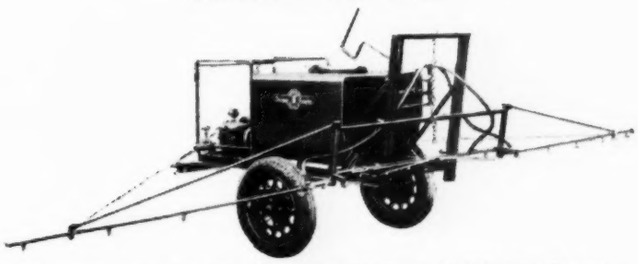

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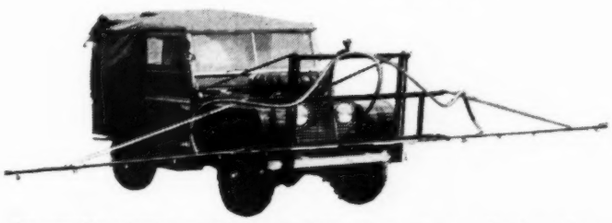

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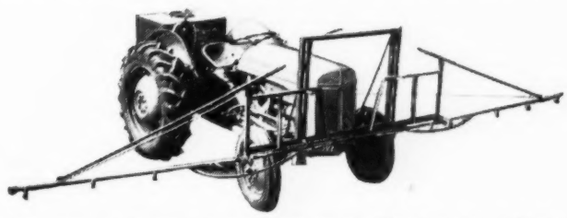

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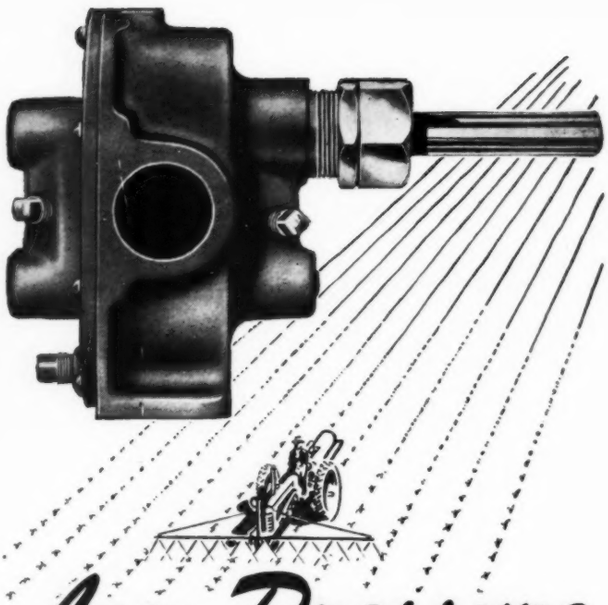

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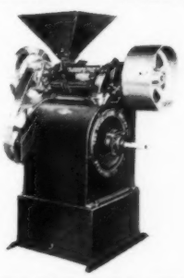

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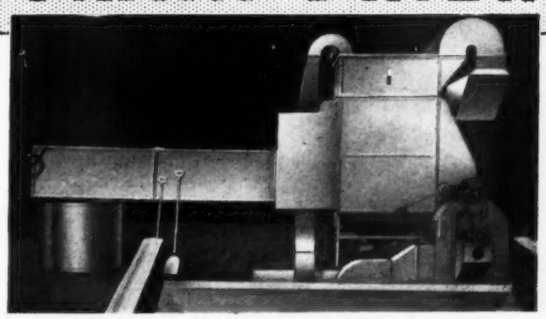

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Illustration shows a Howard Rotavator Heavy Duty Attachment turning in sugar cane trash on the Laxmiwadi Estate of the Godavari Sugar Mills at Kopergaon.

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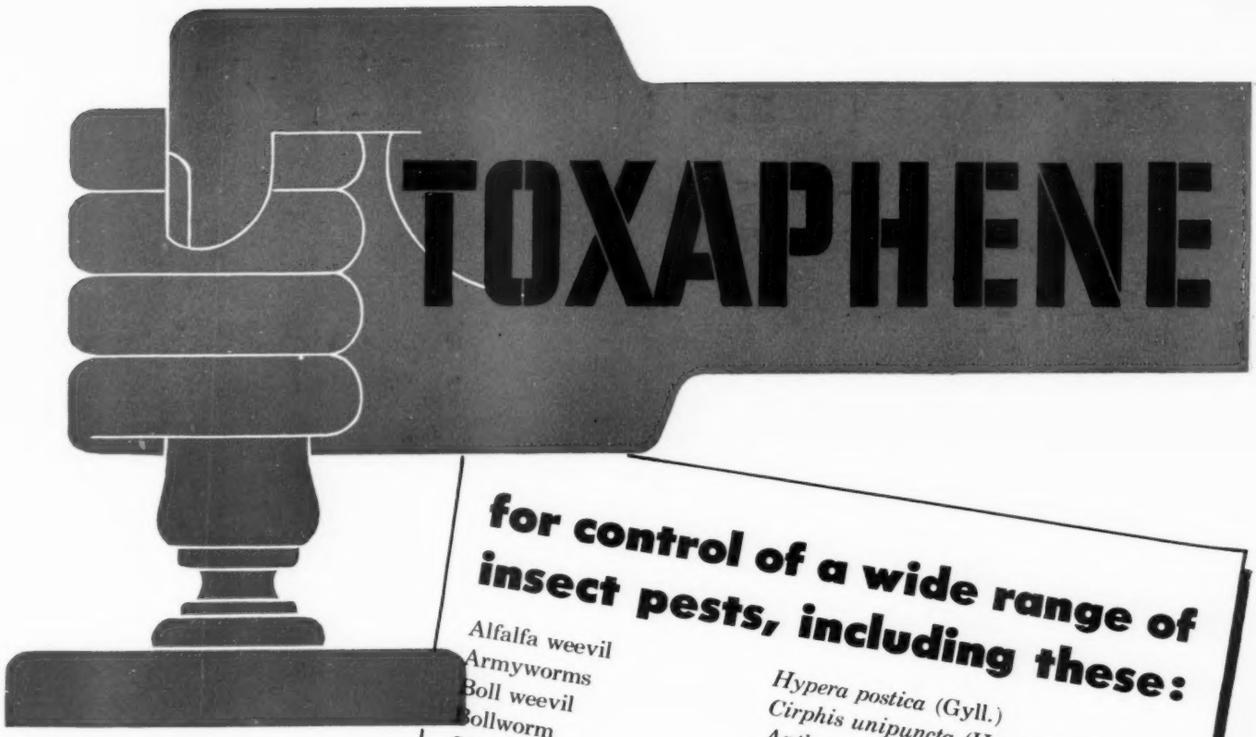

for control of a wide range of insect pests, including these:

Alfalfa weevil	*Hypera postica* (Gyll.)
Armyworms	*Cirphis unipuncta* (Haw.) et al
Boll weevil	*Anthonomus grandis* Boh.
Bollworm	*Heliothis armigera* (Hbn.)
Chinch bug	*Blissus leucopterus* (Say)
Clover seed chalcid	*Bruchophagus gibbus* (Boh.)
Cotton aphid	*Aphis gossypii* Glov.
Cotton fleahopper	*Psallus seriatus* (Reut.)
Cotton leafworm	*Alabama argillacea* (Hbn.)
Cutworms	*Agrotis ypsilon* (Rott.) et al
Grasshoppers (locusts)	*Spp.*
Lice	*Haematopinus eurysternus* (Nitz.) et al
Lygus	*Lygus* spp.
Peanut (potato) leafhopper	*Empoasca fabae* (Harr.)
Rapid plant bug	*Adelphocoris rapidus* (Say)
Salt-marsh caterpillar	*Estigmene acrea* (Drury)
Sheep-tick	*Melophagus ovinus* (L.)
Southern green stink bug	*Nezara viridula* (L.)
Spittlebugs	*Philaenus lineatus* (L.) et al
Sweetclover weevil	*Sitona cylindricollis* Fahr.
Thrips	*Spp.*
Ticks	*Boophilus annulatus* (Say) et al
Velvetbean caterpillar	*Anticarsia gemmatilis* (Hbn.)
Webworms	*Loxostege similalis* (Guen.) et al

List gives common and scientific names approved by the American Association of Economic Entomologists.

Insecticides based on toxaphene (chlorinated camphene 67-69% Cl) are now recommended in the United States for controlling a wide variety of insect pests, including those listed here. This list is increasing steadily as field tests are completed satisfactorily on other species. If your Department of Agriculture or Experiment Station has not fully tested toxaphene dusts or sprays against insect pests in your area, write for specific details.

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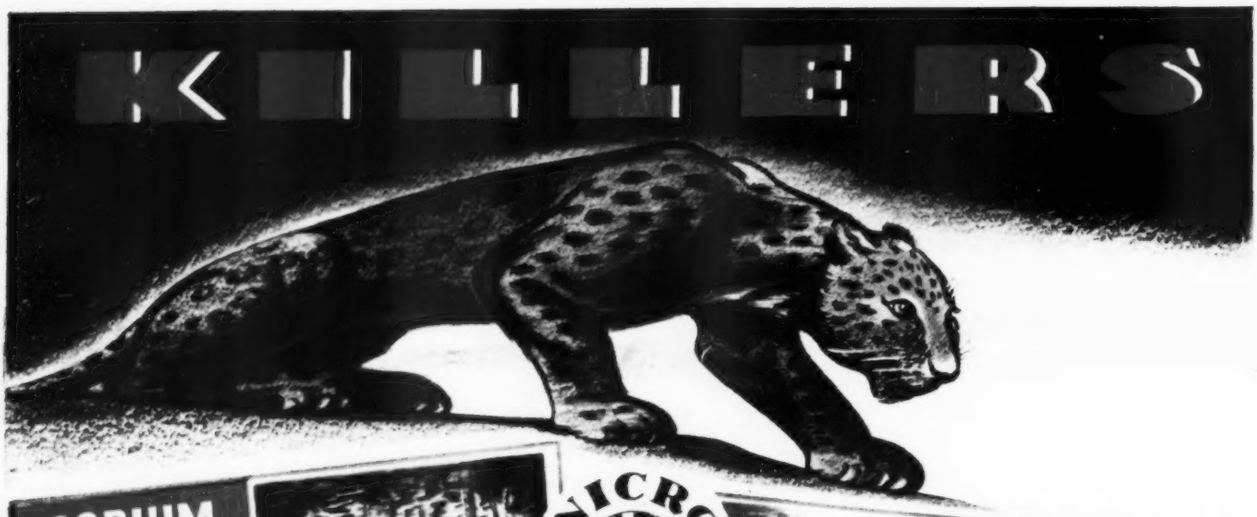

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For the control of grass type weeds in certain varieties of fruit and vegetables.

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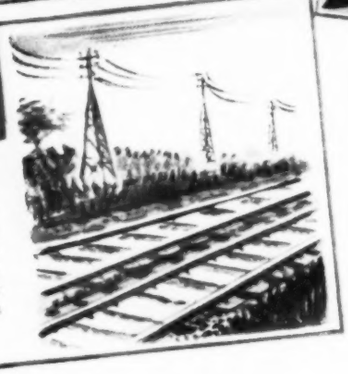
Alone or mixed with 2, 4-D is recommended for the clearance of scrub, blackberry and young trees from pasture land, roads or rights of way, without reducing the grass population.



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